engineering & services

Air Force
Engineering and Services
Quarterly

AFRP 85-1 VOL 21 NO 4 NOVEMBER 1980

Satisfying the demands of energy
with concern for the environment

From the Director

Greater Ingenuity and Cooperation

The President, speaking in Louisville, Kentucky, on 31 July 1980, stated, "We will ... protect our environment ... with commitment, with imagination, with courage, with America's vast technological genius and with our vast resources ... We can meet our energy needs while we preserve the quality of the precious land, air and water."

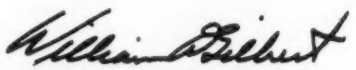
We've dedicated an immense amount of manpower and money in pursuit of these goals. Our success has been applauded by many; however, the 1980s will demand even greater ingenuity, cooperation and resources.

During this decade, we will move into more advanced technologies. As yet undeveloped ideas must economically and safely convert our central energy plants to coal, for instance. Solar, geothermal, wind, biomass and other renewable resource advances must be applied. We will soon be using new, efficient engines, fuel cells, generators and boilers. However, each must be in tune with our environmental concerns.

The continued interest in the environment is emphasized by recent demands in the areas of identification and control of hazardous waste, correcting past disposal practices, and the need to examine our processes which generate hazardous materials. There is increased public involvement in our actions, and preservation of archaeological and cultural resources has been a matter of increasing concern. We must recognize that the demand for pollution abatement programs will be, in many cases, pushing state-of-the-art technology.

Working cooperatively with the other military services, the Department of Energy and the Environmental Protection Agency, several Air Force agencies have planted the seeds from which our energy future will grow in harmony with the environment. As they grow, the Engineering and Services community must become smart in those energy technologies which show promise and in the environmental impact of these new technologies. This means education and intelligent resource planning. It means involving ourselves with the public and their commitment. It means a willingness to work within a strict set of rules. But more than anything, it means an exciting challenge.

I am confident we are prepared to accept that challenge. As in the past, our professionalism and dedication to that challenge will command success.



WILLIAM D. GILBERT
Major General, USAF
Director of Engineering and Services

Examples of the efforts by Engineering and Services people to meet the challenges of energy and the environment are documented in this issue.

AIR FORCE
engineering & services
QUARTERLY

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DISTRIBUTION: F. The QUARTERLY'S annual subscription rates are $6.00 domestic; $7.50 foreign; $1.50 per copy. Mail check or money order to Superintendent of Documents, Government Printing Office, Washington DC 20402. Reader per copy ratio: 5 to 1.

The **Air Force Engineering & Services Quarterly** is an official non-directive Headquarters US Air Force publication, published quarterly under provisions of Chapter 12, AFR 5-1. Its purpose is to provide Air Force Civil Engineering and Services personnel with a timely and comprehensive picture of the importance, wide ranging involvement and direct relationship of civil engineering and services activities to successful accomplishment of the Air Force mission. It provides current information about significant civil engineering and services programs and accomplishments throughout the Air Force; pertinent developments in science engineering and management; and educational/training opportunities for enhancing professional thought and development. The **Quarterly** is edited and published by HQ Air Force Engineering and Services Center, Tyndall AFB, Florida. Contributions, suggestions and criticism are welcome. Opinions expressed do not necessarily reflect the official viewpoint of the Department of the Air Force, the Director of Engineering and Services or the editorial staff. Authority to publish this periodical automatically expires on January 1981 unless its continuance is authorized by the approving authority prior to that date.

Since 1969, environmental regulations have become increasingly complex and have placed great demands on Air Force activities. We will need continued dedication and professional team effort to meet the

Challenges from the Environment

by Lt Col Thomas E. Peot

During the past decade there has been an increasing awareness of the necessity to preserve public health and the environment. This public awareness has resulted in complex legislative actions which have mandated stringent environmental regulation. The National Environmental Policy Act (NEPA) of 1969 and Executive Orders have directed that Federal agencies take a leadership role in environmental enhancement. NEPA is the basic statutory reference for conducting and documenting the Environmental Impact Analysis Process (EIAP).

The Environmental Protection Agency (EPA) was formed at the beginning of the decade to centralize environmental management and to act as a focal point for environmental issues. Since then, environmental regulations have become increasingly complex and have placed great demands on Air Force activities.

DOD policy now requires Air Force facilities, not presently in compliance with applicable Clean Air or Water Act standards, to negotiate compliance agreements with regional EPA offices. More recently, the Resource Conservation and Recovery Act (RCRA) of 1976 has placed a staggering impact on Air Force resources. EPA has promulgated most of RCRA regulations to protect public health and the environment from improper use and disposal of hazardous wastes. The Endangered

Species Act, the National Trail System Act, and the Wild and Scenic Rivers Act were enacted in the late 1960s and accelerated during the 1970s — recognizing the importance of the nation's natural resources. In FY 1979, funding was provided for the first time under the Sikes' Act for significant outdoor recreation, fish and wildlife projects.

The Air Force has recognized the importance and increased tempo of environmental programs and has been the leader among Federal agencies to ensure compliance. Civil engineering functions were realigned with environmental planners and engineers from base level to the Air Staff to actively pursue these important programs. The Air Force Engineering and Services Center (AFESC), at Tyndall AFB, Florida, as a separate operating agency and an arm of the Air Staff, focuses on many worldwide engineering and services activities including environmental planning. The Environmental Planning Directorate provides guidance and assistance to major commands, bases and other Federal agencies on environmental matters ranging from environmental assessments, pollution abatement, economic consequences studies, bird aircraft strike hazard problems, comprehensive planning, hazardous waste disposal, pest management, Air Installation Compatible Use Zone (AICUZ), noise planning, quality of life studies, range planning, natural resources management, endangered species protection, cultural preservation, and others. This list is not exhaustive, but it illustrates the nature and scope of the Center's — and the Air Force's — involvement in environmental matters.

Between 1967 and 1979, approximately $300 million was spent on pollution abatement; and over $160 million is programmed for nearly 300 water and air pollution abatement projects from now until 1984. This does not begin to show the economic impact of recent regulations to implement the Resource Conservation and Recovery Act. Over 300 installations report 3,210 potential air pollution sources, but only 22 installations are in noncompliance with the Clean Air Act. In water pollution, 133 Air Force bases are required to obtain 175 National Pollutant Discharge Elimination System permits, and 23 are presently in noncompliance with the Clean Water Act.

Staying abreast of applicable legislation dealing with evolving environmental issues is overwhelming, and the volume of statutory and regulatory laws continues to grow daily. It is vital to have close cooperation and coordination between Air Force lawyers and engineers at all levels. There will be an ever-increasing reliance on and demand for legal advice and assistance in environmental management. Air Force Judge Advocates require a working knowledge of environmental law, regulatory programs and policies, and are prepared to give prompt professional advice when requested. Early and active interface between engineers and lawyers is critical to ensure recognition and identification of environmental concerns before they become problems.

Staying current in any specialty is the mark of a true professional. Supervisors can help their engineers and planners stay current by periodically scheduling them to attend seminars, symposiums, and other professional workshops on environmental matters. Training is applicable at all levels of command.

It seems legislation begets compliance which begets work. Simple programs evolve into massive projects. Resources aren't normally increased to accommodate new requirements, but instead, the engineer or manager does more with less. Emphasis at the Center is to develop procedures which streamline our work and prevent problems from occurring.

The Environmental Technical Information System (ETIS) is one example of reducing the workload of the engineers and planners. ETIS is a package of three main computer programs designed to ensure consideration of the total environment and thereby improve the quality of Air Force decision making in environmental matters. One program identifies potential impacts on the environment, another forecasts socioeconomic impacts, and the third program lists applicable environmental laws. Using ETIS saves valuable time during the Environmental Impact Analysis Process.

... protecting the environment

The Environmental Planning Directorate contracts for environmental support studies and other technical services for Air Force wide application through the Investigative Engineering (IE) Program. Normally, projects include investigation of new methods, procedures, criteria and equipment, ways to eliminate hazards, feasibility studies, development of new regulations or manuals, and studies in support of Air Force litigation including development of expert testimony. Projects under the IE program are normally beneficial to engineering and services worldwide.

Streamlining procedures and developing a smarter approach seems to be the only way of meeting the challenge in a world of changing priorities, dynamic programs and new requirements. A methodology for conducting local economic consequences studies for Air Force realignment actions, base closures or significant mission changes has been developed and is currently being refined for Air Force use. Another study, when completed, should eliminate repetitious, manual data gathering and reporting requirements now required for recurring pollution abatement reports.

The Center is constantly working solutions to real environmental issues encountered at bases Air Force wide. As an example, four California bases were issued Notices of Violation for non-compliance with rules governing the storage of JP-4 fuel. A project was initiated to exempt JP-4 storage and dispensing facilities from air pollution requirements. If successful, the California bases may be able to forego the installation of $4 million in vapor control equipment.

The mission of the pest management function is somewhat different from that of the rest of the Environmental Planning Directorate. While most of the Directorate works to keep pollutants out of the environment, the USAF Pest Management Program annually injects thousands of pounds of known toxic chemicals — pesticides of all descriptions — into the environment. AFESC works constantly to insure that pesticides are applied in the minimum amount necessary to achieve pest control and to minimize pesticide risks to the environment and to human health.

A number of programs are in effect to insure environmentally sound pesticide use in the Air Force. Perhaps the most important of these programs is Integrated Pest Management (IPM). Basically stated, IPM is a pest management technique whereby chemical control of pests is minimized and control methods such as sanitation, construction and biological control are emphasized. The DOD IPM program was recently praised by the President's Council on Environmental Quality.

Pest management programs at installations are carefully managed before, during and after execution to maximize environmental safety. Air Force guidance specifies that all installations will submit pest management plans and pest control contract statements of work to the major command for review by a test management professional. The plans and SOWs are reviewed for environmental, as well as control, sufficiency. Pesticide usage records from all installations are forwarded to AFESC quarterly for examination. Any questionable submissions are discussed with the submitting command. All of these requirements help to identify and eliminate any abuse of the environment by improperly applied pesticides. In summation, Air Force pest managers have always been concerned with eliminating environmental pollution caused by pesticides, and their concern will continue as long as there are pests to control.

Birds too can be a problem. Birds on runways, taxiways or infields create an immediate safety hazard that must be eliminated for safe flying operations. A successful bird control program can include pyrotechnics, bioacoustics, depredation and other methods. Land use management must be a primary consideration in the

... restocking lakes and streams

Proclamation

WHEREAS, THE PENGUIN IS AESTHETICALLY PLEASING IN DESIGN, AND

WHEREAS, EVERYTHING ABOUT THE PENGUIN IS CLEARLY BLACK OR WHITE; AND

WHEREAS IT COULD NEVER FLY; AND

WHEREAS, IT HAS AN ELEGANT STANCE; AND

WHEREAS, IT FACES ALL DECISIONS WITH COLD FEET AND HUDDLES TOGETHER IN GROUPS; AND

WHEREAS , IT HAS FEW FRIENDS EXCEPT FOR THOSE OF ITS OWN KIND; AND

WHEREAS, IT IS CONSIDERED TO BE A STRANGE BIRD;

THEREFORE, BE IT PROCLAIMED THAT WE DO HEREBY ADOPT THE PENGUIN AS THE SYMBOL OF THE

ENVIRONMENTAL PLANNING

Bird / Aircraft Strike Hazard (BASH) reduction program. The proper locations of landfills, sewage lagoons or agricultural crops as well as maintenance of grass heights and forest species are of utmost importance. Our BASH team provides guidance and field assistance in developing and maintaining active bird strike reduction programs.

Environmental challenges extend beyond direct operations and mission support. They include technical assistance and planning for recreational, physical fitness, educational and energy conservation benefits on Air Force installations. National Recreation Trails make

... cleaning up litter

up one such initiative which provides outdoor recreation close to urban areas. DOD selected four Air Force trails for nomination to the Heritage Conservation and Recreation Service to become National Recreation Trails. The results can be attributed to the tremendous success of the Youth Conservation Corps and Young Adult Conservation Corps programs on Air Force bases. These programs provide not only the funding and labor for complishing needed projects but also orient young people to living and working together with the natural environment.

Government agencies and public interest groups are increasing the pressure to force disposers of hazardous materials to clean up existing or abandoned disposal sites. Federal, State and local governments are developing strict, new regulations to require disposers to identify the locations and contents of disposal sites and take action to eliminate hazards in an environmentally responsible manner. DOD policy is to control the migration of hazardous contaminants from DOD installations and to abate contaminants that have an adverse environmental impact. To implement this program, commands are developing priorities for disposal site surveys and conducting records research of past disposal activities to perform and evaluate site surveys and develop mitigative actions where necessary.

Air Force activities are unique in type, size, location or timing, and methods used in the civilian sector for environmental assessment and pollution control are sometimes inadequate to solve Air Force problems. New technologies, methods and procedures are continuously sought by the Center's Research and Development Laboratory to assist Air Force managers in assessing and minimizing potential environmental impacts of future operations and weapons systems. Air Force Environmental Quality Research and Development is pointed toward:

- **Development of solutions not available in the civilian sector for solving Air Force problems which impact on mission accomplishments;**
- **Development of pollution control techniques for unique operations and equipment;**
- **Development of standards and criteria for chemicals and other environmental contaminants where none exist; and**
- **Retrofiting existing technology for more cost-effective utilization.**

The Research and Development Laboratory not only addresses immediate problems but devotes a substantial effort to next generation weapon systems and new Air Force missions.

As we move into the 1980s, the "Super Projects", such as the M-X Weapon System, Space Shuttle, Ground and Air Launched Cruise Missiles, and Over-the-Horizon Backscatter Radar System pose monumental and highly sensitive challenges to Air Force environmental engineers and planners. The environmental issues involving the siting and acquisition of land for the M-X Weapon System have already proved to be overwhelming. Environmental planners are currently involved in the comprehensive planning of new operating bases in support of the M-X Weapon System. Using the comprehensive planning approach, the new bases are being planned, integrating state-of-the-art design, energy conservation, and a living and working environment conducive to outstanding performance. We have met the challenges of the environment during the past decade, and we will need the same dedicated, professional team effort to meet the challenges of the 80s.

E&S

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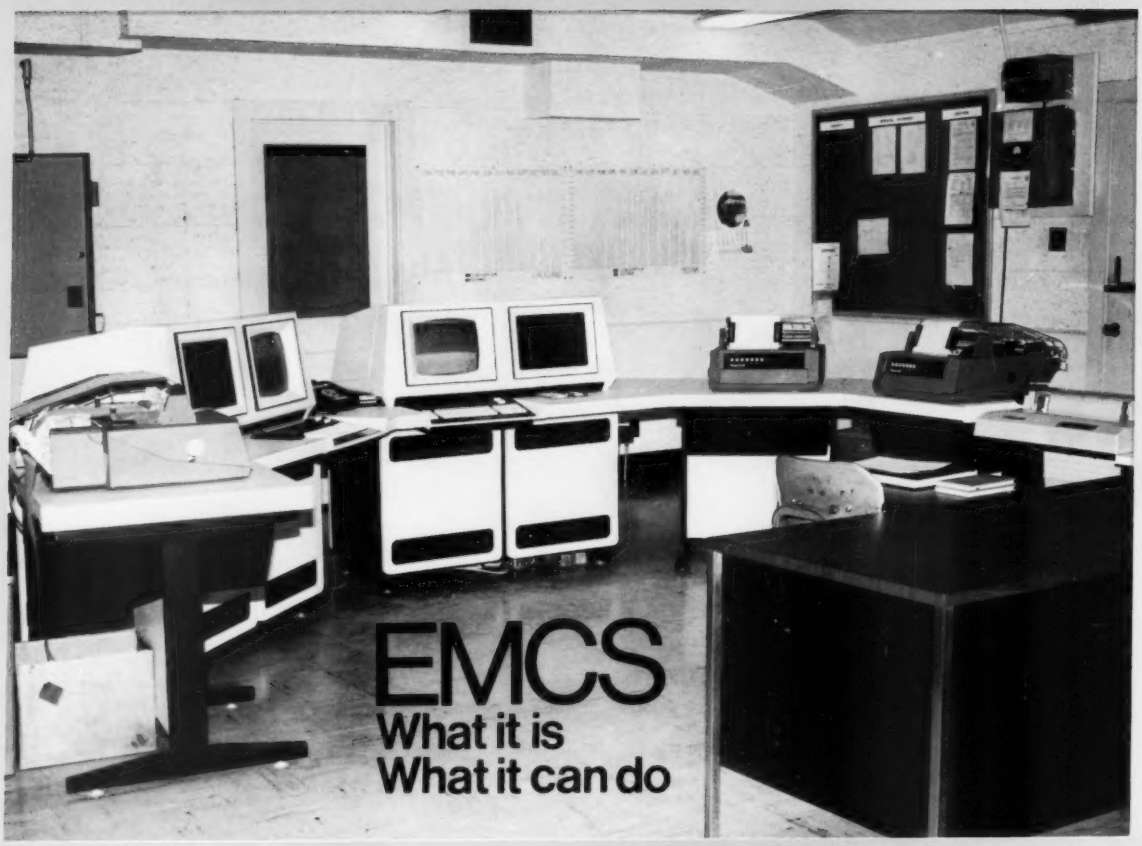


EMCS
What it is
What it can do

. . . the single most effective step
in an energy conservation program available today.

by Edward H. Ling, PE

A building automation system of the 1960s and 1970s that has been upgraded with the technology of the 1980s to serve not only a single building but an entire base is the Energy Monitoring and Control System (EMCS). It is a system which allows more effective use of the mechanical and electrical O&M work force, and is the single most effective step in an energy conservation program available today.

An EMCS allows more effective use of the O&M work force on a base. The system is broken down into three major components: central station equipment, communications link and field equipment.

The central station equipment (the heart of the system) is a computer and an operator's control console. The console consists of a keyboard, display screen, printers on which alarm conditions, operating logs, and other system data are produced.

The communications link connects the central station equipment and the field equipment. It can be telephone lines, dedicated cable, or conceivably a FM radio link. Telephone lines have the marked advantage of being cheap and, generally, sufficient telephone pairs already exist on base. The disadvantages are the slow rate of communications and especially low-quality of lines on many bases.

Dedicated cable such as coax or triax has the advantage of a high rate of communications and reliability; however, it is very expensive. The cost is not a deterrent in itself because the rapid paybacks of an EMCS can satisfactorily carry the cost of a dedicated cable system. It is possible to use FM radio links or fiber optics for a communication link. However, neither have been used to any degree at the present time.

Field equipment, the third major component, is made up of Field Interface Devices (FIDs), sensors, controls, and multiplexors. The FID contains a microprocessor which has about the same processing capability as the central station equipment in the older model EMCSs. It can compare actual values of various monitored functions to limits placed in its memory and alarm upon any

condition outside the limits. It can perform time-of-day starting and stopping of equipment and with sufficient memory installed, it can provide optimized starting and stopping of equipment and other optimization routines. The FID gives the systems the ability to operate when either central station equipment has failed or the communications link has been lost with central.

The FID obtains its information from multiplexors (MUXs). The MUX receives the signals from the various sensing devices, then translates them into digital form, conditions them, and transmits them to the FID. It also changes the digital commands given by the FID or the central station equipment into analog signals acceptable to the sensing devices or relays.

The last portion of the field equipment is the individual sensors and controls. These are temperature sensing elements, starting relays, control point adjustment output devices, pressure sensors, PH sensors, and all wiring related to these points or sensors. This part is the major cost of an EMCS.

Basically, there are three concepts of application of an EMCS, although many combinations or blendings of the concepts occur. For ease of discussion, they are labeled as follows:

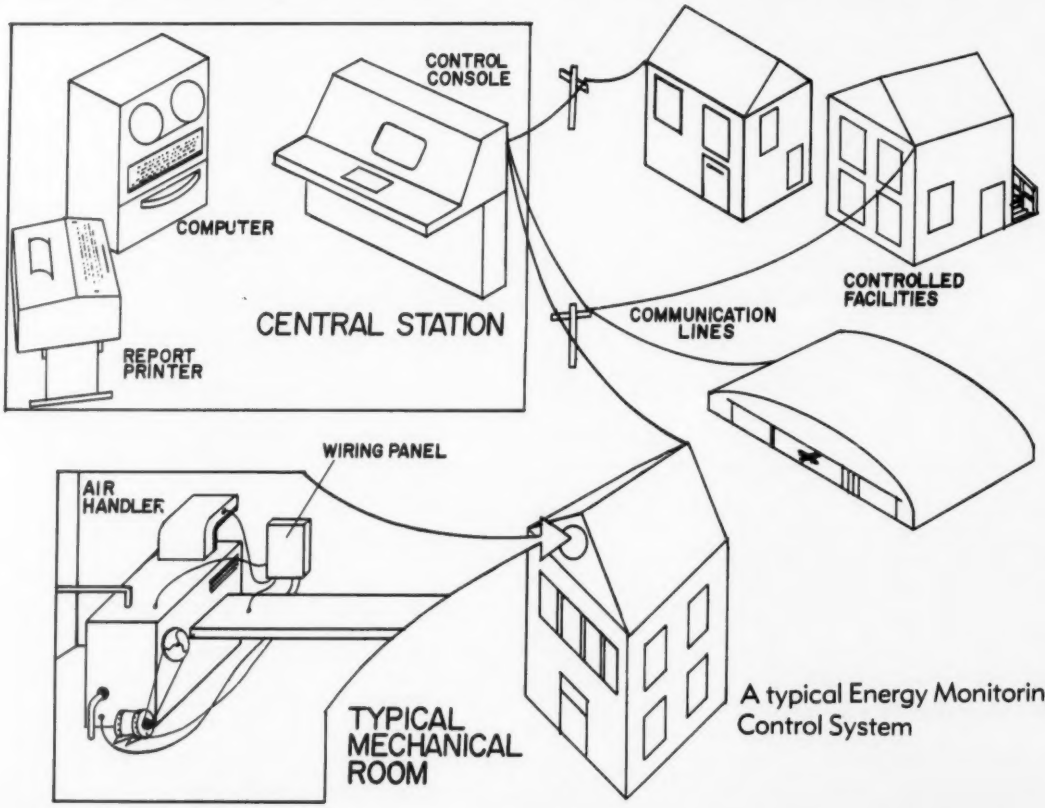
- **Level A: Basic Energy Conservation;**
- **Level B: Maximum Energy Conservation;**
- **Level C: Full Engineering Application.**

Level A application simply provides start/stop control of equipment such as Air Handling Units (AHUs). This can be done manually or by computer. This capability for unoccupied shut-off is the single most effective energy saving routine available via EMCS. Two points per AHU are required for this application as indicated on the sample address schedule, **Figure 1.** Only one point is required if proof of flow is not required.

Although Level A points are relatively expensive ones ($/point), this application gives the most rapid payback. Some equipment manufacturers claim as low as nine months payback and a reduction of some 20 percent in energy consumption. Industry claims a maximum of 2½ years payback. Duty cycling and demand limiting can be performed by use of a computer on this application level.

Duty cycling refers to the program of turning equipment off for short periods of time. This reduces electric demand charges as well as electric energy consumption. The addition of a computer or hardwired logic allows a peak demand control program (demand limiting). This program uses actual electrical KW demand, forecasts demand for the remainder of the demand period, and turns off preselected loads if required to avoid exceeding a predetermined maximum demand.

Level B application normally encompasses a computerized control system which in turn permits the ap-



A typical Energy Monitoring Control System

plication of numerous optimization routines engineered to conserve maximum energy. Some of the computer routines are optimized Start Time Program; enthalpy optimization Program (outside air economizer); supply air reset; chiller profile optimization; temp constrained duty cycling; and Night Set Back.

The Level B concept for maximum energy conservation requires a computer and several additional points over a Level A system. For the sake of illustration, consider the address schedule (I/O Summary) for a typical large three zone air handling unit, **Figure 1.** This concept requires 12 points more than Level A.

- 3 space condition temperature points;
- 3 space condition temperature reset points;
- 2 cold deck points (temperature and reset);
- 2 hot deck points (temperature and reset);
- 1 return air temperature point; and
- 1 return air enthalpy point.

The differences between Levels A and B have to offset the additional costs. However, maximum energy conservation is desired so long as the overall project complies with DOD criteria. Using the typical example in the sample address schedule, the points would increase from two for Level A to 14 for a Level B application. Sizeable savings from the temperature constrained duty cycling program are expected. In addition, the other various optimization routines result in reduced chiller and/or boiler loadings which reflect a marked energy reduction over the Level A concept.

Level C application uses the full capability of the current generation of EMCS. It saves maximum energy and provides a significant maintenance as well as a management capability. The console operator can trouble-shoot HVAC and various other utility systems from the console. High pressure natural gas and oil fired boilers can be monitored and controlled from the console rather than by full-time plant operators. Water storage and distribution systems can be operated from the console. Sewage treatment plant operations can be monitored sufficiently to preclude full-time plant operators on the night shifts. Electrical equipment in substations can be operated remotely, thus improving reaction time in case of an emergency. In a case where two substations can be balanced and backfed to level the demand peaks, that operation can be controlled at the console. Maintenance tasks can be programmed by the computer tracked equipment run times as well as from other information obtained from the computerized system.

Computer based maintenance scheduling offers significant advantages for operations and maintenance. Filter cleaning can be reduced to that which is accurately identified as essential by measuring pressure drops across the filters rather than by programming on a regular calendar basis. Filter pressure drop monitoring, however, involves one extra point. Another example is scheduling periodic maintenance on air handling units. Maintenance schedules will be based on actual equipment running time. Totalized run time is essentially a free item on computer based systems. Computer based maintenance scheduling will become increasingly important as features are utilized such as night shut-off and optimized start times. With these routines, equipment run times will no longer track the typical calendar schedule. The duty cycling and other routines will result in a wide variance in equipment running times by zones within a building, and most certainly from building to building.

The Level C concept involves additional monitoring points. Considering the typical address schedule in Fig. 1, an additional 8 HVAC points are required over the Level B application: three supply air temperature sensors; one chilled water return temperature; one hot water return temperature; one firestat alarm; one freezestat alarm; and one filter pressure drop sensor.

From a point count approach on the attached AHU example address schedule, the maintenance capability involves eight of the 22 points, or some 36 percent of the system. However, that analysis is not truly representative of the cost increase. Since the central station equipment cost is essentially the same for all levels of application for a base wide system, the cost per point can vary from less than $50/point to over $300/point, based on the number of points.

Analysis of numerous EMCS contracts, both before and after the advent of the Tri-Services Guide Specification, reveals an average cost per point for Level C systems of $300 to $370/point. These point costs are only for the field equipment and do not include central station or communication link costs. Analysis of a limited number of Level A or B systems indicates costs per point of $600-$1,000 per point. Thus, comparison of the number of points for Level A, B and C systems is not a comparison of relative costs of the systems. Further, the overall benefits of the Level C application far outweigh a Level A or B system.

It is obvious that one can benefit by having a well thought out application approach prior to the design stage. Adequate funds must be available. Cost/benefit information on various applications is required. That information, unfortunately, is gained from actually designing and using one or more systems. The above experiences were gained by ATC in the process of actual design of five base wide systems and expansions for four other systems, all of which totaled some 30,000 points as well as the operation of several Level C systems for several years. E&S

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CESMET tips

The Air Force Civil Engineering and Services Management Evaluation Team (CESMET) reviews, evaluates and assists Base Civil Engineering and Services functional areas in accomplishing their mission in the most effective and efficient manner. This department is designed to pass along new ways to do the job better.

> We present Certificates of Outstanding Achievement to base personnel who are doing absolutely "top-notch" work. One certificate was presented during the last three months.
>
> Lowry AFB--TSgt Paul F. Michaelson, Transportation Fleet Manager

FIRE PROTECTION — The scope of "off duty" education for fire fighters is dependent on two factors: (1) the emphasis placed on the program by the fire chief and (2) the availability of courses. The interest of top management is, by far, the most important and it directly affects course availability. We have seen some very extensive programs with high participation rates. At each of these locations the fire chief worked with the Base Education Office getting the right courses offered, many times in the fire station. At every base where education interests are high the department reaps many benefits--higher morale, better qualified personnel, etc. It may take some effort but is well worth it.

BUDGET — There is one common characteristic we have observed that ties all the stronger Civil Engineering Financial Management Operations together--total involvement in all budgeting aspects by the personnel assigned. Without exception, the stronger financial management functions have everyone aggressively involved in all financial aspects of the organization. We often see bases where the funds manager is intimately involved with the overall funding situation, but the other financial management personnel are just "go-fers." We offer you a challenge: In today's environment can you really afford not to get the entire financial management function totally involved?

SUPPLY — Are your Civil Engineering material control personnel fully trained? We still find personnel who are not aware of the BCE material control class at Lowry AFB, Colorado. This excellent two-week, one-day course provides vital information on BEAMS, COCESS, AF Form 1445 and other Civil Engineering related supply functions. The prerequisites? One must carry AFSC 64550, be military or civilian (must be GS-4 or higher) and have six months experience in Material Control. Contact your Training Section and review AFM 50-5 for details.

CONTRACTING — We have seen some disturbing trends in the administration and management of family housing renovation contracts. Discussions with HQ USAF staff agencies resulted in a study conducted under the DOD Acquisition

(continued on next page)

Management Review Program. A report was issued in June 1980 (AF 80-2F-2) and is available for review and possible implementation. The report discusses current renovation contracts and reviews organization, staffing, technical compliance, payments and project management. It also provides recommendations for use in preparing and monitoring renovation contracts. If you have a housing renovation project underway or programmed, this report can be useful to you. It is available from your major command headquarters or HQ USAF/LEEH.

TRANSPORTATION Backing accidents occur all too frequently, as any commander or supervisor knows. Recently, we saw a technique that dramatically reduced the number of backing accidents. The practice, borrowed from a commercial concern, requires the driver to place an international orange traffic cone at the rear of the vehicle when it is parked. This did the trick! The driver has to walk behind the truck to pick up the cone before backing up. The cone is tied to the truck with a short piece of rope so loss is prevented and the driver who fails to "look behind" is easily identified.

SERVICES Among responsibilities of the base services officer is the very sensitive one of providing honors to deceased military personnel. One of the best military honors programs recently observed by CESMET is at K.I. Sawyer AFB. To ensure a high degree of proficiency, the honor guard participates in a wide variety of ceremonies and portrays an excellent Air Force image to the civilian community. Team members are presented a plaque and letter of recognition for every 100 hours of service. An excellent pamphlet titled Honor Guard Instructions has been developed by the NCOIC of Mortuary Affairs for use by members of the honor guard. For additional information on this successful program contact TSgt Eric Pederson at AUTOVON 472-2846.

CIVIL ENGINEERING At K.I. Sawyer AFB we saw a good idea for informing customers on the procedures to obtain service through the customer service unit. They have prepared an informative brochure outlining the best ways to get quick service. If you would like a copy, contact MSgt Daniels, Customer Service Unit, AUTOVON 472-2196.

Are your Structural Maintenance and Repair Teams (SMART) totally effective? The following tips are based on several very good SMART functions we have seen and should make your SMART operations more effective.

* The bench stock should have over 150 line items.

* The SMART schedule should never determine the length of stay in a facility. Rather, it should be based on the type of facility and level of maintenance required.

* The schedule should remain dynamic which allows changes to meet requirements.

* The facility inspections should be performed with the building manager.

* All minor maintenance should be done and work reported that is not within the SMART capability.

* The team should be augmented with shop personnel when faced with large or specialized maintenance and repair.

Tactical Air Command is facing up to a tough environmental issue by taking aggressive action to objectively evaluate the impacts of essential training requirements on endangered raptors. You might say it's a case of

The Birds & the Booms

by Lewis Shotton

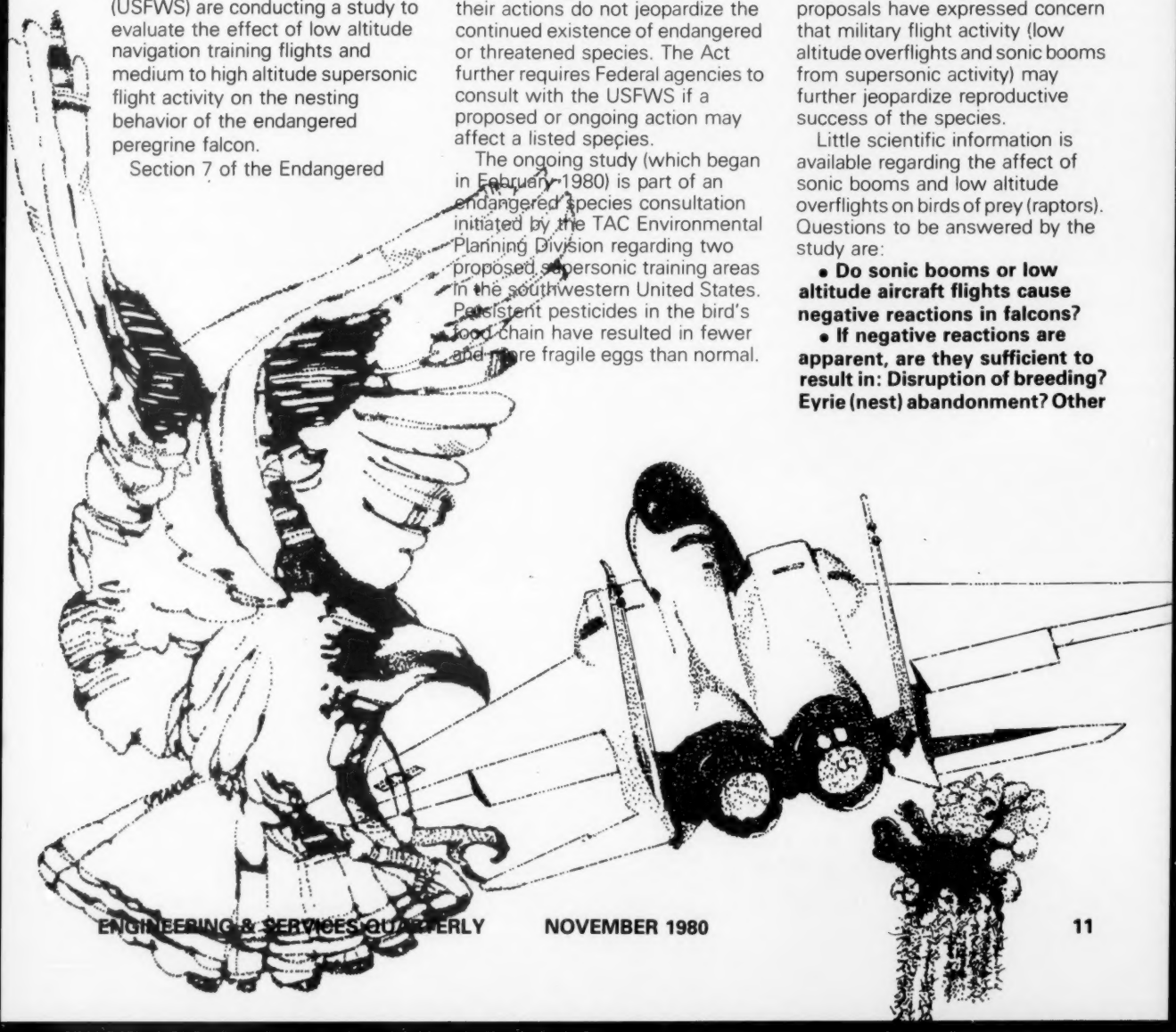
Tactical Air Command and the US Fish and Wildlife Service (USFWS) are conducting a study to evaluate the effect of low altitude navigation training flights and medium to high altitude supersonic flight activity on the nesting behavior of the endangered peregrine falcon.

Section 7 of the Endangered Species Act of 1973 requires that all Federal agencies ensure their actions do not jeopardize the continued existence of endangered or threatened species. The Act further requires Federal agencies to consult with the USFWS if a proposed or ongoing action may affect a listed species.

The ongoing study (which began in February 1980) is part of an endangered species consultation initiated by the TAC Environmental Planning Division regarding two proposed supersonic training areas in the southwestern United States. Persistent pesticides in the bird's food chain have resulted in fewer and more fragile eggs than normal. Consequently, some reviewers of the supersonic training area proposals have expressed concern that military flight activity (low altitude overflights and sonic booms from supersonic activity) may further jeopardize reproductive success of the species.

Little scientific information is available regarding the affect of sonic booms and low altitude overflights on birds of prey (raptors). Questions to be answered by the study are:

- **Do sonic booms or low altitude aircraft flights cause negative reactions in falcons?**
- **If negative reactions are apparent, are they sufficient to result in: Disruption of breeding? Eyrie (nest) abandonment? Other**



Little scientific information is available regarding the affect of sonic booms and low altitude overflights on birds of prey, namely the peregrine falcon.

severe behavioral responses?

• If negative reactions are identified which will have major adverse impacts on the species, what are the estimated limitations (distance from the nest and seasons of the year) for supersonic or low altitude aircraft flight that will avoid the reactions?

The study is designed to first evaluate the impact of tactical training flights on non-endangered falcon (raptor) species. If severe reactions are not apparent, USFWS field researchers will then evaluate the reactions of endangered raptors.

Data are being gathered regarding the effects of low altitude flights on falcon behavior from actual low altitude jet aircraft overflights. Units supporting the study with low altitude training flights are the 355 Tactical Training Wing (TTW) at Davis-Monthan AFB, Arizona, the 58 TTW at Luke AFB, Arizona, and the 162 TFG (Arizona Air National Guard (ANG)) stationed at Tucson International Airport. All of the supporting flights are normally scheduled low altitude training sorties; however, the sorties are coordinated with the field researchers to fly close to designated nesting sites at scheduled times.

Sonic boom experimental situations are being accomplished with acetylene cannons and ground launched mortars. The booms generated by aerial bursts from ground launched mortars have much higher overpressures (up to 15 psf) than peak overpressures associated with aircraft generated sonic booms (about 1 to 3 psf). The usefulness of observing falcon responses to aerial mortar bursts is limited to that of determining if overpressures far greater than those generated by supersonic aircraft have any major adverse impacts.

Blinds are placed at great enough distances from the eyries that field researchers do not stress the raptors while they are being studied. A typical data gathering sequence for a low altitude overflight would be as follows:

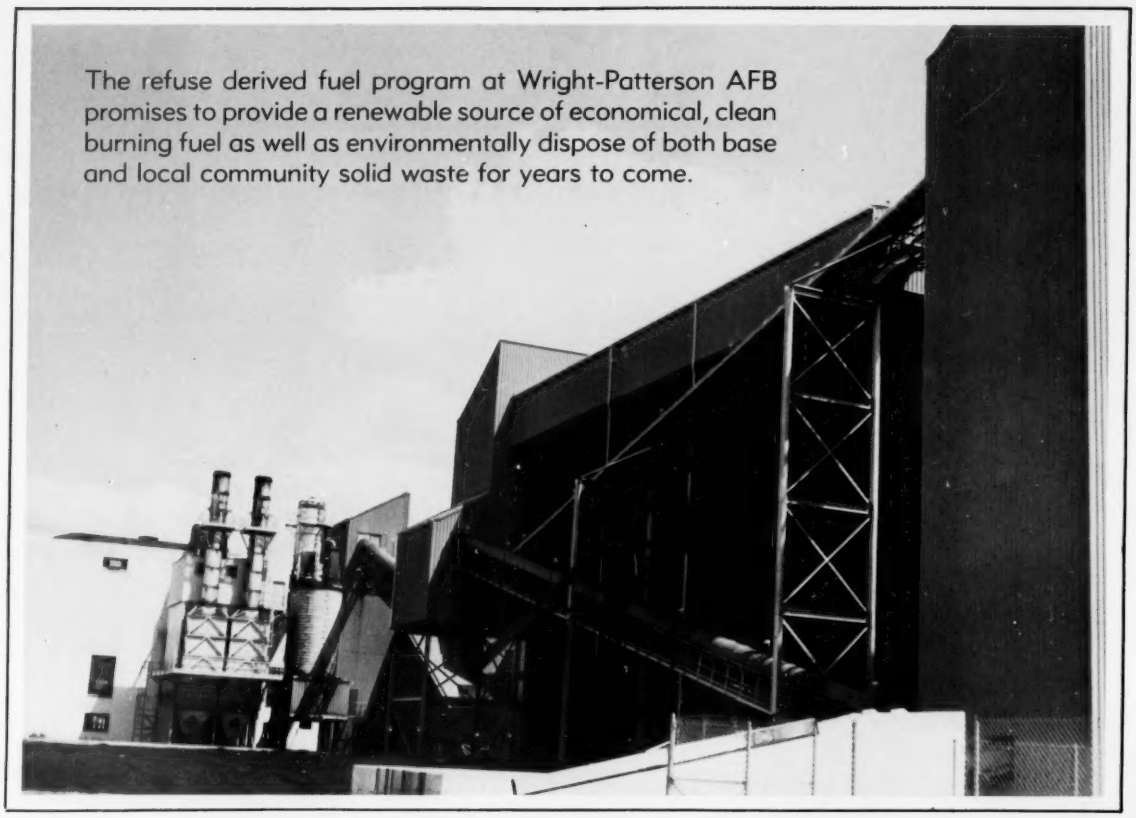
- The observers concealed in a blind are notified by radio of the projected time of overflight;
- Using a tape recorder and stopwatches, the behavior of the birds is recorded for the half-hour periods preceding and immediately following the overflight. Some post-stimuli periods may be photographically recorded;
- Pertinent data are transferred to form sheets for subsequent extraction and statistical analyses; and
- The observers prepare for the next recording sequence.

The field data collection portion of this study was completed in August 1980. The preliminary study report is now being evaluated to determine if additional study is necessary. If additional study is not required, the study will conclude and the USFWS will be asked to provide a biological opinion and recommendations based upon the information gathered. If data collected in the study indicate a more extensive evaluation is needed, then a proposal for a study addressing physiological as well as behavioral responses with captive birds will be prepared by the USFWS researchers. The proposal will be considered by TAC and the USFWS Endangered Species Office.

The importance of this study to the TAC training mission is obvious. At the request of the USFWS, all aircraft using military training routes and low altitude tactical navigation areas scheduled by TAC units or TAC gained ANG units, are now avoiding known peregrine falcon nesting sites pending the results of the ongoing study. In addition, decisions to use future supersonic military operating areas (MOAs) overlying endangered raptor habitat will consider the results of the study. (There are no known peregrine falcon nesting sites beneath existing Air Force supersonic MOAs.)

The Tactical Air Command is facing up to a tough environmental issue by taking aggressive action to objectively evaluate the impacts of essential training requirements on endangered raptors. E&S

LEWIS SHOTTON *is the Natural Resources Manager for Tactical Air Command, Langley AFB, Virginia. He received his bachelor's degree in biology from Virginia Military Institute and his master's degree in marine science from the University of Virginia. He is an associate member of the National Wildlife Federation.*



The refuse derived fuel program at Wright-Patterson AFB promises to provide a renewable source of economical, clean burning fuel as well as environmentally dispose of both base and local community solid waste for years to come.

Trash to Energy Via RDF

by Leon Glaspell, PE, and Thomas E. Shoup

As an unknown philosopher once said, "You can only be certain of two things — death and taxes!" For today's civil engineer, two more certainties can be added — "too little energy supplies and too much trash." But if the abundance of one can offset the shortage of the other, some relief can be obtained from both problems. Wright-Patterson AFB, Ohio has been developing this concept of using trash for energy for the past five years with remarkably encouraging results.

Fuel from waste or refuse-derived fuel (RDF) is far from a novel idea. The burning of trash to produce energy is a practice more than a century old in the industrially developed countries of Europe where modernized plants have greatly increased in number over the past 20 years. But the idea has been slow to catch on in the US until recently for two main reasons. First, our fuel combustion equipment has historically been designed to burn a high quality, homogeneous fuel and second, relatively cheap energy costs provided little incentive to use lower grade, less consistent fuels. As late as only five years ago, the thought of burning wood chips, paper waste or RDF in DOD boilers sent plant engineers into a frenzy. So why have attitudes changed? Without elaborating on the obvious, energy costs are far from cheap, but just as importantly, refuse disposal costs are also skyrocketing. Part of the increased cost for disposal is of course related to energy inflation, but an additional factor is the cost for compliance with Environmental Protection Agency regulations for landfilling solid waste.

In many metropolitan and suburban areas where there are DOD installations close by, landfills are being

exhausted while the cost of developing new sites rivals the cost of systems once thought to be far too exotic and expensive. "Resource Recovery," "Energy Recovery," and "Mass Burning With Waste Heat Recovery" are names for economically feasible alternatives being considered by many local governments. So how do Air Force facilities fit in with these "Recovery" plans? For one thing, Air Force bases tend to produce "high quality trash" compared to normal municipal solid waste. Seriously, our solid waste typically has a high percentage of combustibles and relatively low moisture content. Consequently, our trash makes excellent feed stock to resource recovery plants. Secondly, considering proposed coal conversion programs, many of our boilers may be replaced or modified to switch from natural gas or oil to coal. Co-firing RDF with coal results in reductions of sulfur dioxide emissions up to 50 percent as compared to burning coal alone. These lower emission rates could permit operation of new coal burning sources without the use of sulfur removal equipment such as expensive flue gas desulfurization processes. Perhaps more importantly though, use of solid waste as an energy source provides an environmentally preferred disposal method for up to 90 percent of the waste stream volume and reduces our dependence on all nonrenewable natural energy supplies.

For several years, Wright-Patterson AFB has been experimenting with RDF as a supplement to coal in existing base boilers. In July 1975, densified RDF, prepared from typical municipal solid waste, was burned in a base boiler during a five-day test. The conclusions of this short-term test were encouraging:

- **Firing a one to one RDF/coal mixture (by volume) caused no significant problems;**
- **Stack emission tests generally showed a beneficial effect on the environment; and**
- **Firing the one to one mixture resulted in only a nominal impact on total ash handling and hauling operations.**

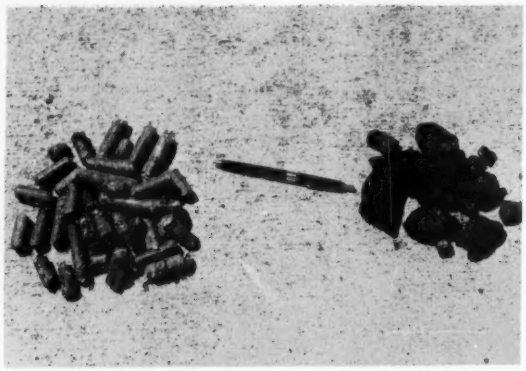
This early testing and several other short-term tests conducted across the country clearly indicated one thing: **a long-term test under actual day-to-day load conditions was necessary to evaluate the performance of RDF.** Under the auspices of HQ Air Force Logistics Command, the base accepted this challenge to provide the needed long-term data base. The long-term test was broken into three phases.

Phase I was simply designed to gain experience in handling, mixing and burning RDF for the plant operators. Little scientific evaluation was planned, but all facets of the operation would be carefully watched and documented for possible problems and areas that needed more investigation or analysis.

Phase II was established as the technical testing and evaluation segment of the research effort. Here with the support of the Facility Research and Development Program at the Air Force Engineering and Services Laboratory, Tyndall AFB, Florida, engineering and scientific personnel would analyze and evaluate the performance of fuel handling equipment, combustion equipment and pollution controls. A critical assessment of the occupational effects on manpower workload, safety and health would also be made. The goal of this phase would be to form definitive design criteria for retrofit projects or new military boiler installations which would allow for reliable use of RDF and other alternate solid fuels.

Phase III would be a demonstration of how successful the new boilers and new handling equipment could perform with only slight modifications or operational adjustments as recommended from the findings of Phase II.

In March 1979, a two and one-half year contract was awarded to Teledyne National for 18,500 tons of densified RDF. The pelletized fuel is being manufactured in Cockeysville, Maryland, and shipped via truck or rail the 500 miles to the base. Contract cost



Comparison of refuse-derived-fuel pellets and coal being burned at Wright-Patterson AFB, Ohio.

for the fuel is $27.00 per ton F.O.B., Cockeysville. A comparison of the physical properties of the Teledyne RDF and coal is shown in **Figure 1.**

Deliveries under this contract were timed to blend with major construction activities underway at the base's heating plants during FY 1979 and FY 1980. The $37 million modification program was directed to attain compliance with particulate air pollution standards, but also included automated coal handling equipment including covered storage silos. The first plant scheduled to be completed was Building 1240. However, the completion date for this facility was April 1980, a full year after award of the RDF supply contract.

To accommodate receipt and mixing of the fuel and thus begin Phase I immediately, minor modifications were made to Heating Plant Building 770. Since RDF must be stored under cover, a small silo was placed over an existing coal reclaim hopper to accept RDF deliveries and store the fuel until mixed with coal. A conveyor belt and transfer structure were also added to transport the fuel mix to an empty railcar which delivered the mixture to the heating plant about 200 yards away. No other modifications were made to the

coal handling, feeding or firing equipment. Boiler operators treated the mixture the same as coal, adjusted boiler controls as necessary to maintain proper combustion, and noted any significant observations on the daily logs.

The first shipments were received at Building 770 in May 1979 by truck for a demonstration and shakedown of the new system. The materials arrived in excellent condition, moved easily through the handling equipment, and mixed well with the coal. With the confidence of these early truck shipments, arrangements were made for the first rail shipments in July 1979. The cars selected for the trial run were covered hopper cars typically used for rail transport of grains and other dry granular material. The first rail shipment arrived on 31 July 1979 with 57 tons of RDF aboard after spending more than two weeks on the rails. As expected, unloading the car was a major project. The long, jerky ride, plus the "incubation" of the RDF in hot covered compartments, disintegrated the pellets and reduced the shipments to fluffy, unpelletized RDF. Personnel spent two days rodding, scraping and pushing the RDF from the car.

	RDF	Coal
Energy Content (BTU/lb)	**6500-7000**	**13,500-14,000**
Moisture Content	**14%**	**5%**
Ash Content	**11%**	**7.5%**
Sulfur Content	**0.1%**	**0.7%**
Bulk Density (lbs/cu ft)	**35**	**45-50**

Figure 1: Physical Properties of RDF and Coal.

After a few minor changes, two more unsuccessful attempts were made to ship the RDF by rail. Three conclusions were reached. One, the practice of "humping" railcars to make up a train acts to densify or consolidate the contents of the railcars and prevents free flowing removal of the RDF. The affect of air tight seals on the hopper cars was of little value versus covers that merely protected the shipment from rain. Two, RDF cannot tolerate long transportation times. As a rule of thumb, if the material sets idle for more than five days, considerable difficulty can be expected in unloading operations regardless of the hopper car angles or discharge opening size. Three, rail shipments of RDF may be possible if the height of the hopper is reduced to 8-10 feet and the hopper bottom resembles the discharge arrangement of a typical coal car.

Currently, the details of another rail transportation attempt are being completed with the rail carrier. Two coal cars with fiberglass lids have been located and they promise to offer the best chance for successful rail delivery. Yet to be resolved, however, is the problem of the long on-the-rail time between Baltimore and Wright-Patterson AFB. In the meantime, shipments by truck have maintained the integrity of the pellets and provided for timely deliveries as scheduled. To date, all truck deliveries have been easily unloaded and mixed well with coal.

In all solid fuel operations, easy retrieval from storage and proper material flowability are primary concerns. While all initial test runs showed that RDF responded well using coal handling equipment, large quantities had never been handled or stored for more than a few days at a time. The most critical problem encountered was identical to the situation experienced in unloading the railcars. After about five days in the small storage silo, the RDF "ratholed" or plugged, requiring considerable effort to flow through the feeder. These problems were experienced to a small degree with truck shipments but were aggravated by the high fines content of the railcar shipments. The best results were always obtained when RDF was mixed with coal immediately after receipt or not more than two days later.

An additional impact of poor retrieval and flowability of the RDF was the consistency of the coal/RDF blend. Maintaining a constant one to one ratio was difficult with highly fluctating RDF flow rates. The result of this variability was occasional slug feeding of RDF into the boiler requiring far closer operator attention to combustion controls than typically found when burning coal alone.

The different bulk densities of the two fuels also was cause for concern. Prior to the start of the testing, segregation of the two fuels was anticipated at transfer points in the fuel handling system. The worst segregation was expected at the coal bunker where the mixture was dropped 10-20 feet into the storage volume. Some segregation was noticed due to the the lighter weight pellets rolling down the slope of the conical shaped pile in the bunker. In no instance was segregation considered to be a problem in boiler operation or control.

Regardless of the success in transporting, mixing and handling the RDF, the "proof in the pudding" as they say is determined by how the material performs inside the boiler. To date, the RDF/coal mix has burned well at boiler loads less than 75 percent of capacity. Good control of the boiler is maintained at these levels with little or no smoking, slagging or ash bed clinkering. In most instances, the boiler operators have been able to treat the mix identically to burning coal alone and no major adjustments to grate speed, air flow or stoker alignment were necessary.

Considerable smoking occurred when the boiler was operated at loads greater than 80 percent capacity. This situation coincided with the receipt of RDF by rail when the consistency of the fuel was more "fluff" than pellets. Apparently, the high percentage of lightweight material in the mix created an uneven fuel distribution across the grate surface. Forced draft air was short-circuiting the firebox causing incomplete combustion and smoking. This inability to operate with the fuel mix at or near boiler capacity can probably be

rectified with improved quality RDF and overfire air adjustments.

Two common problems in coal-fired boilers are slagging(or the build up of material on refractory walls) and clinkering (or the fusion of ash into solid masses or sheets.) Significant amounts of material have been deposited on the rear refractory wall since co-firing with RDF began. In a few places the deposits extend outward into the boiler 4 to 6 inches. The obvious effect of this buildup is a reduction in exposed boiler tube surface and reduced efficiency. More importantly though, the slagging can reduce air inlets and restrict the free movement of the chain grates resulting in warping or failure of the grate system. The buildup, considerably more than experienced while burning coal alone, is believed to be caused by glass particles in the RDF. This same problem was predicted after the original RDF test runs in 1975. RDF fines, burning in suspension, migrate to the rear of the boiler and enter a horizontal fire cyclone. The cyclone propels molten glass and ash particles onto the back wall where they adhere to the boiler refractory. Once again, the cure for this problem appears to be controlling the fines content of the RDF through better quality control.

Surprisingly, while some clinkering has been observed, the clinkers do not seem to be much more pronounced than when burning coal alone. Clinkers too can cause grate damage by blocking air flow through the grates and increasing grate temperature. Occasional rodding of the ash bed has been successful in breaking up small clinkers that could adversely affect boiler operation.

On 3 July 1980, the new fuel handling and storage facilities at Building 1240 were turned over to Wright-Patterson AFB by the Corps of Engineers. This milestone also ushered in the second portion of the RDF development program. The new fully automated and covered fuel handling system enables plant personnel to receive, store and mix one truckload of RDF in less than two hours when the same operation could take up to two days at Building 770. With a full year of experience under our belts, a few answers to RDF questions have been found, but as in any developmental program, the answers have generated far more challenging questions.

A large portion of the multi-year Phase II investigation is being performed in conjunction with the Air Force Facility Energy Research and Development Program managed at HQ AFESC, which has been investigating military use of RDF for several years. The overall objective of the RDF research is to evolve criteria and specifications for new and converted military boilers capable of using a wide variety of conventional and alternate fuels, including coal and RDF, without compromising the increasingly demanding performance requirements that base heating and power systems will have during the next four decades. Expert scientific and engineering support has been enlisted for conducting the Phase II evaluation, and several joint agreements have been reached with DOD, private and other governmental agencies and organizations for performing portions of the study. These efforts focus on material handling, conveying and storage; boiler efficiency determinations; corrosion evaluations; and air pollution analyses. Soon to be initiated are efforts to assess the bioenvironmental affects of RDF, determine the overall impact of using RDF on plant management and manpower utilization, and derive new methods and procedures for RDF specification, procurement and quality control.

RDF was first burned in Building 1240 in May, 1980, and observations to date are encouraging. The new fuel handling system is performing considerably better than expected compared to the previous experiences at Building 770. An increased amount of fugitive dust or lint from the RDF has created a nuisance for employees at the heating plant. In response, Teledyne has modified the pellitization process with the addition of a dust collection system to improve the quality of the RDF.

Unlike the boilers at Building 770, the existing boilers at Building 1240 are equipped with high efficiency, electrostatic precipitators. A primary concern was what effect RDF would have on these pollution control devices. Although no stack emission comparison is yet available, continuous monitoring opacity meters continue to register less than 5 percent visible emissions, easily in compliance with Ohio regulations.

Continued on page 34

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TOM SHOUP *is Chief of the Base Environmental Planning Section, 2750 Air Base Wing, Wright-Patterson AFB, Ohio. He received both civil and environmental engineering degrees from the University of Cincinnati. Associated with the Air Force since 1974, he is a member of the Society of American Military Engineers.*

Directorate of Engineering and Services

Current Emphasis

a brief commentary on significant developments

FY 82 MCP GOES TO OSD--$1.7 billion at the minimum level.....the largest Air Force MCP program ever. Major supported programs include M-X ($500M), ALCM ($110M), Wright-Patterson AFB Hospital ($106M), Dorms ($78M), RDF ($58M), ECIP ($50M), MAR ($43M), and Phase IV ($30M). More emphasis on replacement and modernization..... $140M compared with $75 M in FY 81. Prior year MILCON shortfalls also addressed..... $115M set aside to buy out deferred line items. (AF/LEEP).

FACILITIES ACCESSIBLE TO THE HANDICAPPED--A survey by GAO of recently constructed facilities throughout the DOD--to determine if they were accessible to the physically handicapped--revealed a high level of conformance to Public Law 90-480. The only exception was small, non-appropriated fund projects that were, for the most part, controlled at base level. Apparently many base civil engineering architects and engineers are not aware that all military facilities, with the exception of facilities that are solely for able-bodied military, are to be accessible to the handicapped. This applies to appropriated and non-appropriated funded projects and includes new construction and alteration projects. (AF/LEEES/297-4257).

DINING FACILITY DESIGN GUIDE--The Air Force Dining Facilities Design Guide, AFP-42, has been printed and should be available through all base Publication Distribution Offices. (AF/LEEES/297-4257).

MEDAL FOR HUMANE ACTION--All RED HORSE, Prime BEEF and Prime RIBS personnel who participated in Cuban Refugee Resettlement Operations at Eglin AFB or La Crosse Airport may be eligible for this award. Check with your local CBPO. (AF/LEEP).

FOOD SERVICE AUDITS--Recent audits emphasized the potential for fraud, waste and abuse in the management of the food service program. We are expanding A La Carte feeding and have an R&D study underway at USA Natick Laboratory to design a mechanized accounting system for more stringent controls. (AFESC/DEHF).

OPTIMUM COMPUTER FACILITY FIRE PROTECTION--In-house testing by AFESC/RDCF was slated to commence on 15 September 1980. The objective is to identify the optimum and most effective installed fire protection system for use in DOD computer facilities. Estimated completion date for these tests is 1 March 1981. (AFESC/RDCF).

RECYCLING--is the way of the future in the repair and maintenance of Air Force pavements. This is due primarily to the high cost of construction materials, shortage of virgin materials and environmental considerations. To assist the BCE in developing recycling projects we are preparing a recycling manual which will provide a method for selecting the optimum recycling process as well as design guidance and guide specifications. This manual should be available in a year. (AFESC/DEMP).

WILD AND SCENIC RIVERS--Guidance on implementation of the Wild and Scenic Rivers Act and recent Presidential directives has been provided. Bases must ensure that wild and scenic rivers are carefully considered in their comprehensive planning and they must coordinate any plans or actions that might affect wild and scenic rivers with the Heritage Conservation and Recreation Service. (AFESC/DEVN/970-6253).

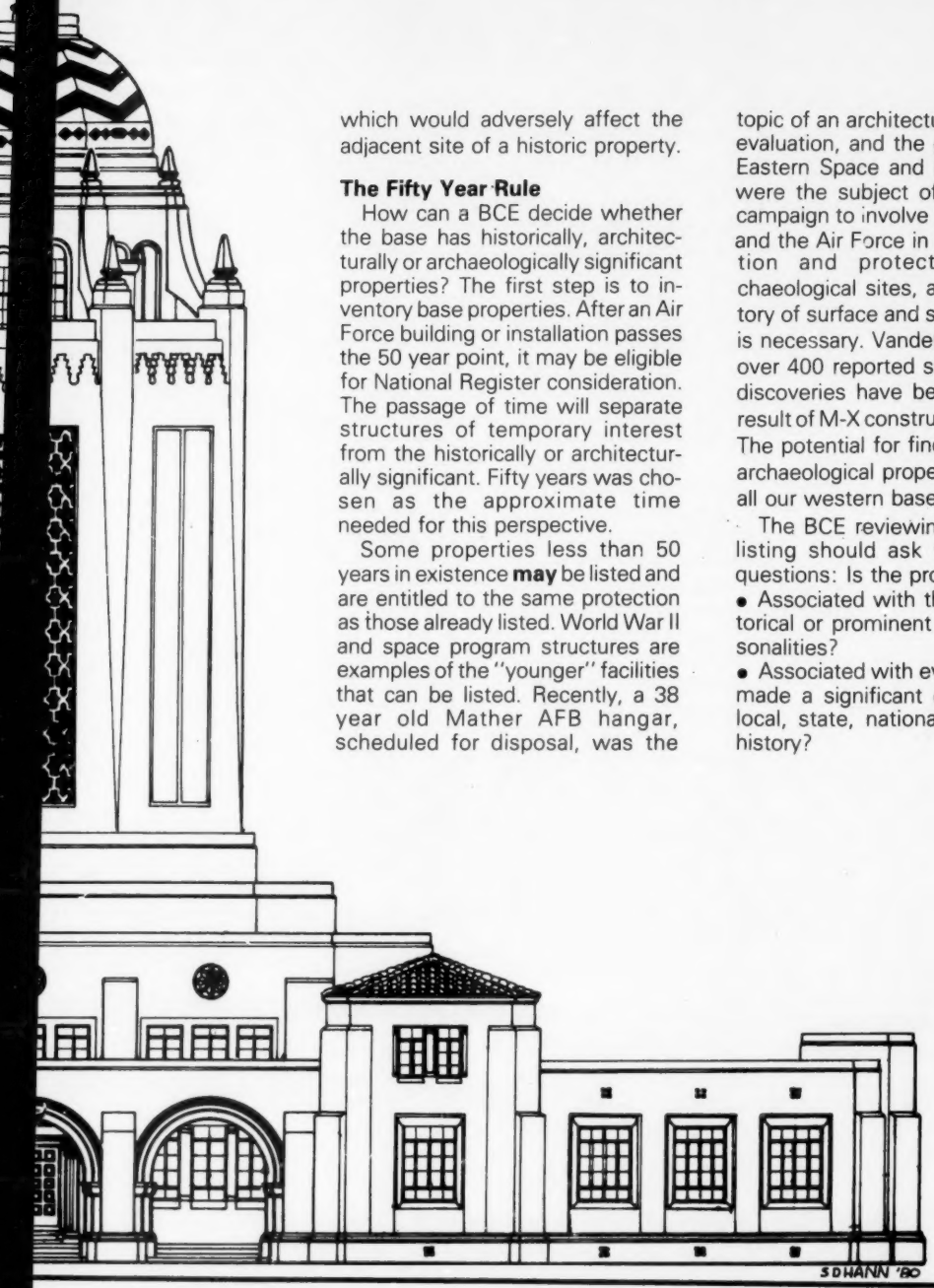
Roots:
Preserving Our History

by Joan Scott and Capt Stephen Hann

Executive Order 11593 states that Federal agencies must locate, inventory and nominate all eligible properties (real estate) to the National Register of Historic Places. Regulations under this Order cover archaeological, architectural and historic properties. Listed properties and those potentially eligible for listing (sites, districts, buildings, structures, objects, static displays) are protected, by law, from modifications which would change their significant features.

The Base Civil Engineer (BCE) must ensure that no maintenance, repair, disposal or new construction actions adversely affect eligible and listed properties. Such actions pertain either to the properties themselves, (new windows, different paint schemes, additions, cable trenches through archaeological sites) or to the nearby areas, or to the construction of new facilities

Protection of Air Force historic properties is one of identifying the roots of our service and enhancing Air Force tradition for future Air Force people. Actions are underway to preserve some of our facilities on the National Register of Historic Places.



which would adversely affect the adjacent site of a historic property.

The Fifty Year Rule

How can a BCE decide whether the base has historically, architecturally or archaeologically significant properties? The first step is to inventory base properties. After an Air Force building or installation passes the 50 year point, it may be eligible for National Register consideration. The passage of time will separate structures of temporary interest from the historically or architecturally significant. Fifty years was chosen as the approximate time needed for this perspective.

Some properties less than 50 years in existence **may** be listed and are entitled to the same protection as those already listed. World War II and space program structures are examples of the "younger" facilities that can be listed. Recently, a 38 year old Mather AFB hangar, scheduled for disposal, was the topic of an architectural and review evaluation, and the gantries at the Eastern Space and Missile Center were the subject of a newspaper campaign to involve the local public and the Air Force in their preservation and protection. For archaeological sites, a careful inventory of surface and subsurface data is necessary. Vandenberg AFB has over 400 reported sites. Additional discoveries have been made as a result of M-X construction activities. The potential for finding significant archaeological properties is high at all our western bases.

The BCE reviewing the property listing should ask these general questions: Is the property:

- Associated with the lives of historical or prominent Air Force personalities?
- Associated with events that have made a significant contribution to local, state, national or Air Force history?

- Characteristic of a type of period of architecture with high artistic value?
- Designed by a master architect?
- A prototype of a construction technique?
- Unique to military architecture?
- An archaeological site containing significant prehistoric or cultural remains?

If the answer is yes to any of these questions and the property is at least 50 years old, it may be significant and will require a survey. A survey describes each facility, highlighting the architectural design features, events or persons that make it significant. The installation historian may help determine events or persons associated with buildings. Local historical groups may also be of help. Other assistance may come from the major command, the Air Force Engineering and Services Center at Tyndall AFB or from architectural and engineering firms which specialize in cultural resources surveys.

Another source is the recently formed Air Force Conservation Foundation. (See box.) The State Historical Preservation Officer (SHPO) may also have helpful information. The initial property review and the completed surveys should be provided to the SHPO for review. The SHPO's concurrence with base evaluations and the survey is important. The determination of significant facilities thereby frees the vast remainder of buildings for modification, disposal or repair without further review.

A Guide to Preservation Law

1. **36 Code of Federal Regulations, Part 1202 ff (formerly 36CFR 60 ff).** This is a synopsis of the Historic Preservation Act of 1966. It describes the national preservation program, the role of the SHPO, and the criteria for determining historical significance.
2. **36 Code of Federal Regulations, Part 800 ff.** Describes the responsibilities of Federal agencies to notify SHPOs of any Federal undertaking impacting historically significant properties, and the role of the Advisory Council on Historic Preservation (contained in Federal Register V 44, No 21, Tuesday, January 30, 1979).
3. **Executive Order 11593.** This EO outlines Federal responsibilities for historic preservation and the obligations of Federal agencies to locate, identify and nominate historically significant properties to the National Register.

An excellent example of Spanish Renaissance Revival is the Cadet Academic Building, now the Headquarters for Air Training Command.

So What?

With the press of everyday crises and demands, spending time with cultural resources management is difficult. An understandable response would be for a BCE to delay acting upon these responsibilities until the people, time and money become available. In reality, this means that the job probably will not get done. The risks in failing to identify and protect historically or architecturally significant properties go beyond simply failing to comply with what may be perceived as some obscure federal laws. In actuality, the law provides that any citizen can nominate significant facilities to the National Register, whether the Air Force wants them to or not. Nomination from sources outside of the Air Force makes the Air Force appear uninterested in its historical assets and unmindful of its responsibilities. Worse, disregarding the impact of an Air Force project on a historically significant property may delay or indefinitely postpone any further action until a full review of the project's impact can be assessed. This could prove costly in time and money for design and construction. On the positive side, recognition of historic properties can add to installation and community pride. As a part of the

The Air Force Conservation Foundation

The Foundation created at the 50th anniversary of the dedication of Randolph AFB is a nonprofit organization, independent of the Department of the Air Force. It aims to foster interest in and appreciation of outstanding Air Force architecture. The Foundation helps installations evaluate the architectural significance of surveyed facilities. AFCF is unable to evaluate archaeological or historical significance. Send copies of blueline drawings (floorplans, elevations, details) or photographs (elevations, all views) with historical information (such as date constructed, additions and modifications, architect, material used) to:

Air Force Conservation Foundation
P.O. Box 642
Randolph AFB, Texas 78148

Indicate your interest in an evaluation and include a self-addressed stamped envelope. AFCF will offer a free evaluation, based on the information submitted. The Foundation regrets that it cannot return drawings or photographs.

year long celebration of the 50th anniversary of Randolph AFB, Texas, the base has reemphasized its architectural and historic heritage. The "Taj Mahal," probably the most unique water tower in the country, Chapel 1, which blends features from several San Antonio missions, the old Spanish style BX and the original ATC headquarters and student barracks will all be evaluated for historic significance.

What It Comes Down To

What all this amounts to is that there is now a body of preservation law which sets forth our responsibilities. The protection of Air Force historic properties is one of identifying the "roots" of our service and enhancing Air Force tradition for future Air Force people. Undue change or destruction of these properties could well raise an embarrassing hue and cry. With everything else we have to worry about, we certainly don't need that.

E&S

The gantry at Cape Canaveral is being pushed for placement on the National Register.

The Vandenberg AFB boat house was recently accepted by the National Register of Historic Places.

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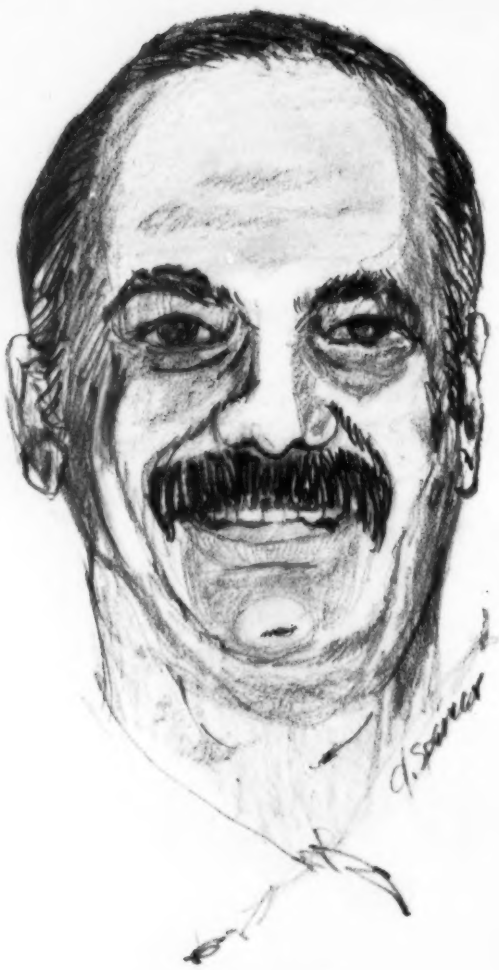
JOAN SCOTT *is a Natural Resources Manager in the Environmental Planning Directorate, Headquarters Air Force Engineering and Services Center, Tyndall AFB, Florida. She earned her bachelor's and master's degrees in resource management from North Arizona University and is currently a doctoral candidate. Before joining the Center in 1976, she was a wildlife biologist with the US Forest Service, Stikine River, Alaska.*

George K. Dimitroff



1934-1980

George K. Dimitroff, longtime editor of this magazine, died unexpectedly October 11 in Atlanta, Georgia.

Born in Weirton, W. Va., and a graduate of Ohio State University, he held several newspaper positions in Ohio before joining the Air Force as an editor at Wright-Patterson Air Force Base, Ohio.

For fourteen years as editor of the Quarterly, he made it one of the most respected and informative publications of its kind. He was especially proud of two coveted national awards he received for his accomplishments from the National Association of Government Communicators.

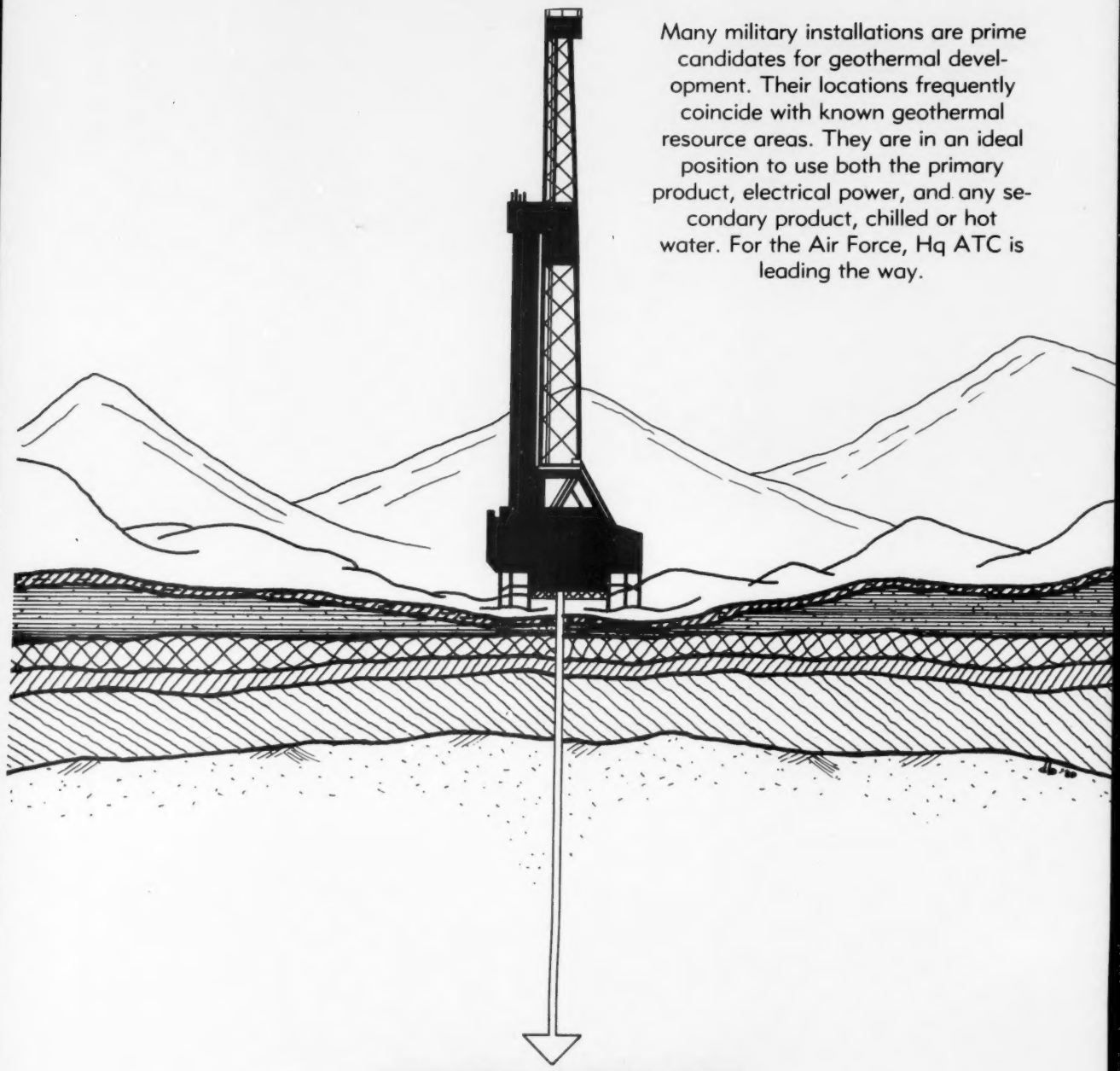
Like any good editor, though, he was never satisfied with his product, and always sought ways to improve it. He was a special kind of editor, with drive and a desire for perfection. Perfection of form and grammar. Perfection of thought. Perfection in clarity and conciseness. Perfection of layout and design. And above all, perfection in accuracy.

But he had more: wit and a quick winning smile, sophistication, and yet a combination of grace and down-to-earthness that put everyone at ease.

For those who labored at preparing articles, he was everpresent with helpful advice. And when there was not enough room for all their articles, he was often successful in getting their efforts into other professional journals. While these things were never required of him, he did them out of a concern for people and their ideas.

To those who knew him as friend and colleague, the loss is personal. For those who did not, these pages reflect the attitude and professionalism of one man dedicated to his profession, his desire to help others and a deep belief in ethics — above reproach.

Many military installations are prime candidates for geothermal development. Their locations frequently coincide with known geothermal resource areas. They are in an ideal position to use both the primary product, electrical power, and any secondary product, chilled or hot water. For the Air Force, Hq ATC is leading the way.



THE HEAT FROM WITHIN THE EARTH

by Richard M. Steede, PE, and Capt Don-Michael Bradford

Supplying the United States with "clean" affordable energy has become a problem of considerable importance in the current climate of unstable petroleum imports, dwindling natural gas reserves, high energy prices and an increasingly polluted environment. Numerous programs are underway to develop renewable energy sources and to focus on resources with few environmental problems. One of these resources receiving attention from the engineering community is geothermal energy — the heat within the earth.

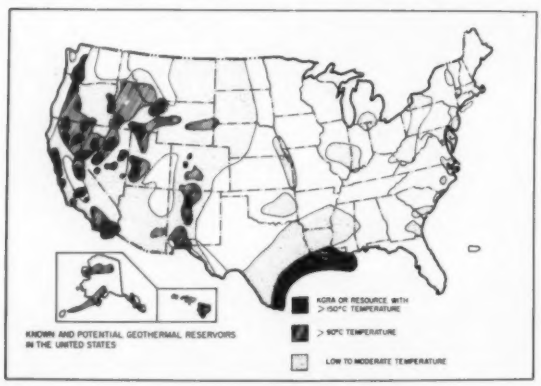
The use of geothermal resources as an energy source traces its development to the Italians in the early 20th Century. In 1913, a 250 KW power station using natural steam was developed in Larderello, Italy. By the 1940s geothermal power plants were feeding some 130 MWs of power for the electrified Italian railway network. Currently there are geothermal power plants supplying a total of 400 MW to the integrated power network of the Italian state organization Ente Nazionale per l'Energia Elettrica. New Zealand began developing the Wairakei area in North Island about 1950 and by 1963 had an installed capacity of 192 MW. Presently, a 165 MW plant is in the development planning.

The major geothermal powered electrical generating plants in the United States are located at the Geysers, 90 miles north of San Francisco. In 1956, two drilling companies successfully tapped the steam and interested Pacific Gas and Electric in building a generating plant. Today, 14 generating units, supplied by 200 wells, produce 800 MW of power — enough to serve a city larger than San Francisco.

The US Navy currently has a contract with a private developer to construct and operate a geothermal electric power generating plant at its China Lake Weapons Range near Inyokern, California.

Electric power generation is not the only application for geothermal resources. Geothermal space heating applications are successfully used in Iceland, Hungary, Japan and Idaho. Geothermal heat application is used for ethanol production, greenhouse heating, artificial soil heating, soil sterilization against insects and bacterial pests before cultivations, crop drying and fish breeding in various countries.

General locations of known geothermal resource areas and potential geothermal reservoirs are shown in map.


KNOWN AND POTENTIAL GEOTHERMAL RESERVOIRS IN THE UNITED STATES
KGRA OR RESOURCE WITH >150°C TEMPERATURE
> 90°C TEMPERATURE
LOW TO MODERATE TEMPERATURE

How It Works

The outer crust of the earth is relatively thin (15 to 30 miles). Below this is a layer of semi-molten rock called the mantle; beneath that is a liquid iron and nickel core. The outer crust is not thought to be continuous but rather consisting of continental "plates" floating on the mantle. In places where two or more plates are colliding or drifting apart and at isolated thin spots in the crust, hot rock (called magma) may come quite close to the surface, occasionally forming a volcano. If magma comes within a few miles of the surface, it may transfer heat to underground water. The hot water can come to the surface as a hot spring or geyser ("fumaroles") or it may be trapped and lie undetected underground. Drilling into formations containing this water can bring hot water or steam to the surface.

Once a resource is in production, geothermal energy can be developed using state-of-the-art technology. For example, the California Geysers produce such high temperature steam that it can be piped directly to turbines to drive conventional electrical generators.

Geothermal resources that produce water at lower temperatures (below 350 degrees F) may use a binary cycle to generate electricity, **Figure 1.** In this power cycle, the geothermal fluid is passed through a heat exchanger where some of its heat is transferred to a working fluid such as pentane, isobutane or freon. The working fluid is vaporized and used to turn a generator. The working fluid is one which has a low boiling point, and, therefore a high vapor pressure. Other attractive facility applications of low temperature geothermal resources include central/district chilled water air conditioning, **(Figure 2)** generated by absorption refrigeration, base-wide central/district heating, and specific facility heating systems.

In combination with geothermal electrical power generation, direct heating and/or absorption chilled water systems can be used to significantly increase the overall plant efficiency by using a low grade energy discharged from generator turbines. Achieving this degree of congeneration, a geothermal power plant located close to Air Force facilities requiring heating and cooling has the efficiency advantage over a utility power

This is the complete geothermal story: drilling the well, left foreground, to the ground steam piping to the generating plant. The electricity is put on the grid via distribution system at the plant.

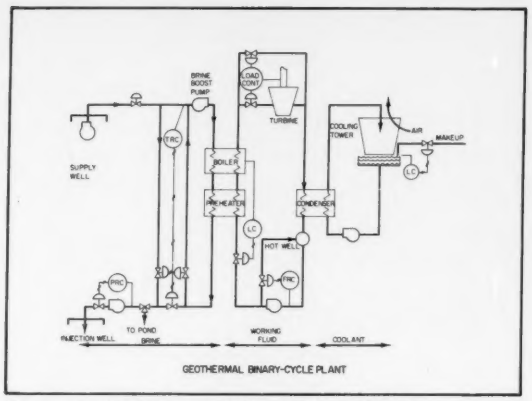


Figure 1: Geothermal Binary-Cycle Plant.

plant by using waste heat from the turbine exhaust.

Geothermal resources can be effectively used in combination with ethanol production plants to increase the overall biomass utilization efficiency.

Los Alamos Scientific Labs (LASL) is studying two methods to be used when insufficient fluid is produced from a geothermal well. Where no fluid exists, two wells are drilled into hot granite, and the formation between them is fractured. The fracture then serves as a heat exchanger for surface water to be pumped down one well and up the other. This process is referred to as the "Hot Dry Rock Concept." The potential of the hot dry rock resource is enormous. For example, the energy from a 40 cubic-mile (167-cubic-kilometer) block of hot granite equals the energy from about 12 billion barrels of oil, nearly the annual total energy currently used by the United States, **Figure 3.**

Where hot geothermal water exists (a hydrothermal resource) but the flow to the surface decreases, LASL's well stimulation techniques can be used. In this situation, chemical or explosives are used to restore flow. When these two techniques are fully developed they will greatly increase geothermal energy application.

Environmental Considerations

There is a belief that geothermal resources represent a relatively clean, nonpolluting energy source and this has played an important role in heightening public interest in geothermal development. Geothermal resources do appear to offer several significant environmental advantages over alternative energy sources, although knowledge of the related environmental impacts is still incomplete.

Since geothermal energy must be used or converted in the immediate vicinity of the resource to prevent excessive heat loss, the entire fuel cycle, from resource extraction to transmission, is located at one site. Unlike fossil fuel or nuclear power production, in which large land areas are required for processes such as mining, refining, transportation, fuel processing and waste disposal, geothermal energy is not a technology that requires a massive infrastructure of facilities and equipment and large amounts of input energy. Geothermal development necessarily involves some disturbance of the earth's surface but the effects are not as severe as

This was the first attempt at a geothermal-powered electrical generation system in the early 1920s.

are those resulting from the surface mining of coal or uranium.

Another environmental benefit arises from the fact that those geothermal power plants that use once through steam as a working fluid to drive a turbine do not need as much makeup from an external source of water for cooling purposes as does a conventional closed loop plant. Because the condensed steam is recycled for that purpose it does not place high additional demands on scarce water supplies.

Not all the potential environmental effects of geothermal energy are positive. Among the most significant adverse impacts of the exploration, development and production of geothermal energy are possible land subsidence, seismic activity, air pollution resulting from the discharge of noncondensable gases such as hydrogen sulfide, high noise levels of drilling and power plant operation, and mineral or thermal pollution of surface and ground waters. Other concerns include increased erosion and sedimentation resulting from site disturbance, possible climatic changes resulting from the release of heat, water vapor, and carbon dioxide and disturbance of soils, vegetation, and wildlife.

The actual impacts of geothermal development can vary widely, probably more so than the impacts associated with fossil or nuclear energy sources. For example, the chemical constituents of geothermal steam or hot water can differ significantly from site to site, causing markedly different air and water pollution emissions from power plants having identical generating capacities. The potential severity of the environmental impacts associated with geothermal development depends on several factors:

- **Type of geothermal resource being developed;**
- **Chemical constituents of the geothermal fluid (steam or hot water) and subsurface rock;**
- **Overall characteristics (geology, hydrology, topography, vegetation) of the development site, both above and below the ground surface; and**
- **Engineering design technologies used to produce energy and control pollution.**

Generalizations about the magnitude and significance of the likely environmental impacts resulting from geothermal development must be based on

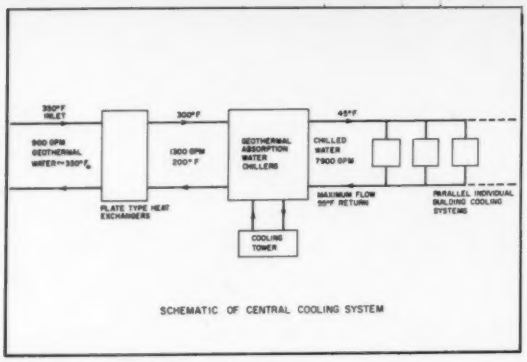


PLATE TYPE HEAT EXCHANGERS
GEOTHERMAL ABSORPTION WATER CHILLERS
CHILLED WATER 7900 GPM
COOLING TOWER
MAXIMUM FLOW 55°F RETURN
PARALLEL INDIVIDUAL BUILDING COOLING SYSTEMS
SCHEMATIC OF CENTRAL COOLING SYSTEM

Figure 3: Heat from Granite.

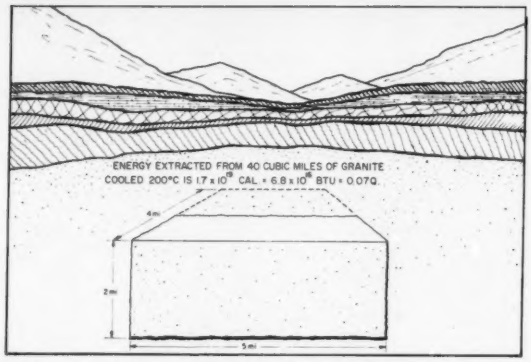


Figure 2: Schematic of Central Cooling System.

careful, site-specific analysis.

Because geothermal development has not been widely pursued, both the likelihood and severity of many impacts are still relatively unknown. Extensive information is available for only a few sites, such as the Geysers and the Wairakei plant in New Zealand. Projections of impacts at other locations where development is planned are still preliminary and highly speculative. Since intensive research on environmental impacts is only just being initiated, it will be several years before a detailed understanding of actual impacts is developed.

Bureaucratic and Funding Considerations

The most vexing problem that keeps geothermal energy from being a panacea to our energy problems is its "wildcatting" nature. We can't just sink a well and be guaranteed of finding exactly what we need. Not only is this a severe physical constraint, but it is also the biggest obstacle to obtaining Air Force funding. If we had a producing well or field, justification and funding for development and application could be through the Energy Conservation Investment Program (ECIP) in the MCP. The problem is that there are no normal Air Force funding mechanisms for drilling geothermal wells because of their high element of risk. Our normal funding routes are based on sure things.

To overcome this hurdle and permit development of a project at Williams AFB, Arizona, Air Training Command (ATC) has negotiated at length with other federal agencies. As a result, a scheme for developing geothermal projects has evolved. A "Memorandum of Understanding" (MOU) between ATC and the Department of Energy (DOE) was signed in May 1980 by the DCS/ Engineering and Services for ATC, and the Acting Manager of the Idaho Operations Office for DOE. This MOU basically set up provisions for funds to guarantee the success of the well drilling operation at Williams AFB. The second feature of the development is based on PL 95-356, Section 803. This law permits energy resource development on a federal military installation by a private concern with the military service compensating that private concern through long term purchases of energy (utilities). The Navy added Section 803 to the FY 79 MCP Authorization Bill to permit development of their project at China Lake Naval Weapons Center, California.

A geothermal project could develop in the following scheme:

- A Request for Proposals (RFP) is issued using the one-step negotiated format. A major evaluation criterion is the life cycle cost of energy to the Air Force over 30 years.
- The successful offeror starts the well drilling operations.
- If drilling is successful and produces economical geothermal energy, the offeror receives 10 percent of the cost of drilling. The remainder of the costs are made up in the long term sale of energy (utilities) back to the Air Force. The offeror then builds and operates the utility plant on the Air Force base.
- If drilling is unsuccessful and does not produce economical geothermal energy, the offeror receives an amount stipulated in the RFP (up to $1,000,000 in the case of the Williams project), and the contract is terminated. These well guarantee funds are furnished by DOE from their "User Coupled Drilling Program."

Adding to these bureaucratic considerations are coordinations required with the particular state regulatory agencies involved in geothermal production and the United States Geological Survey (USGS). The USGS is the federal regulatory agency that enforces safety and environmental regulations during the drilling phases.

To further the development of geothermal energy projects in the Air Force, ATC has been designated to chair a new Facility Energy Working Panel on Geothermal Energy. ATC is streamlining project development by recommending policy on programming, funding, coordination with other federal and state agencies, and technological advances. As chairman of the panel, the DCS/Engineering and Services will meet quarterly with DOE personnel involved in geothermal energy. These quarterly meetings will also be attended by other service representatives.

Current Projects

ATC is currently involved with two major geothermal projects. These are the Williams AFB project and a project involving seven south central Texas military in-

stallations.

Williams AFB is situated in the southwestern half of the Higley basin east of Phoenix. In 1973 Geothermal Kinetics, Inc. (GKI), a consortium of mining, oil and utility companies, drilled two wells about a mile southwest of the base, the deepest being 10,454 feet. Data from these wells indicate that temperatures approaching 400 degrees F might be expected at depths of 10,000 to 11,000 feet.

In June 1979, EG & G Idaho, Inc, under contract to DOE's Idaho Operations Office, published the results of a study of the geothermal potential at Williams. Its study concluded that the Air Force could develop a two-phase project consisting of a production well phase at $4.6 million and construction of either a 4300-ton central cooling or a 9 MW electric power plant. It estimated that the central cooling plant would cost approximately $9.4 million with a simple payback of 11 years and that the central base electric power plant would cost $22 million with a 15 year payback.

Air Training Command

Air Training Command contracted with Westec Services, Inc, San Diego, to prepare a Request for Proposal (RFP) using the project development scheme described above. The RFP will allow proposals for electric power generation, central chilled water, or a combination of both. ATC expects to award a contract by early 1981. Public Law 95-356 requires contract approval by the Secretary of Defense and notification of the Senate and House Armed Services Committees. Well drilling is targeted to begin sometime in mid-1981.

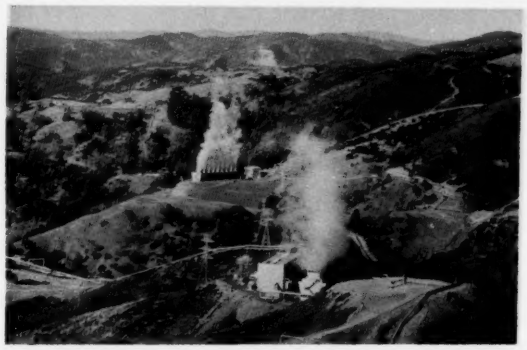
The Texas geothermal resources, situated along the Balcones and the Luling-Mexia-Falco fault zones in central Texas, are currently being studied by the University of Texas's Bureau of Economic Geology under a DOE grant. At ATC's request, DOE has recently increased the Bureau's grant to cover specific military applications within this region. The expanded study will investigate the geothermal energy potentials at Fort Sam Houston and Bergstrom, Randolph, Brooks, Lackland, Kelly and Laughlin AFBs.

It is expected that geothermal resources in the region of the Texas project will generally be at depths less than 5,000 feet. The relatively low temperatures predicted for this region indicate possible application to space and domestic water heating for specific facilities rather than central basewide electrical power generation or air conditioning.

Upon receipt of the Bureau's study, a consultant will be hired to study specific facility energy profiles and to match these to the capabilities of the geothermal resource to determine life cycle effectiveness. For facilities demonstrating economic feasibility, the consultant will also prepare the RFP for further project development under Section 803 of PL 95-356 and well guarantee provision as described above. Drilling of the first well for the Texas project will hopefully start during the first half of 1982.

Conclusions

Many military installations are prime candidates for potential geothermal development. Their locations, on large tracts of land, frequently coincide with known geothermal resource areas (KGRAs). They are in an ideal position to use both the primary product (e.g., electrical power) and any secondary product (e.g., chilled or hot water) so that overall plant efficiency can be maximized. The funding phase is involved because of the element of risk, but with joint DOD/DOE initiatives and development by private firms under PL 95-356 and other significant legislation, this can be overcome. With today's technology and increasing knowledge of geothermal applications we are steps closer to directly mining energy and reducing our dependence on imported and nonrenewable resources. E&S



Two power plants and steam distribution lines are shown in this photo of the Geysers area.

RICHARD STEEDE *is Chief of the Mechanical Engineering Branch, Engineering and Construction Directorate, Headquarters Air Training Command, Randolph AFB, Texas. He received bachelor's degrees in mechanical engineering and mathematics from Texas Tech University. A registered Professional Engineer in Texas, he is a member of the American Society of Heating, Refrigerating and Air Conditioning Engineers.*

CAPTAIN BRADFORD *is the Command Environmental Protection Planner, Headquarters Air Training Command, Randolph AFB, Texas. He earned his bachelor's degree in government from Southwest Texas State University and his master's degree in environmental management from the University of Texas. He is a member of the Society of American Military Engineers.*

Keeping current in one's practicing discipline is an almost impossible task. The Energy Group at the Air Force Engineering and Services Center has developed a plan to get information to the right person at the right time. It's called

FACILITY ENERGY TECHNOLOGY TRANSFER

by Ed E. Wilson, PE, and Capt Philip C. Holden

Base Civil Engineers (BCEs) have a bundle of jobs. They design all sorts of systems by themselves, seldom the same one twice. They provide engineering opinions on everything from doorknobs to aircraft. They consult with other engineers on projects for which they have scheduled little time. They attend schools, consult with resident engineers, inspect construction projects, talk with shop technicians, answer base commanders' questions, brief high interest projects, prepare for inspections, and routinely consult with every conceivable activity on base. And they try to keep current in their discipline.

In the energy field, keeping current is perhaps the most difficult. With over 30 technologies to be concerned with and a limited staff of practicing engineers at each base, it is literally impossible to stay current in all technologies. Yet, somewhere within the Air Force, someone is current or can quickly become current in each. The problem is, how does the information get to the right person at the right time?

The Air Force Engineering and Services Center's (AFESC's) Technology Transfer Program is designed to solve that problem. It distributes four documents, unsolicited, directly to the Air Force Engineering and Services community.

First, the "Energy Newsletter" provides up-to-date information about events in the energy world. It is an across-the-board look at Air Force, Department of Defense, Department of Energy and civilian activities. It may contain an article such as the one you're reading, tips on conservation (no, we haven't done all the "easy" things), O&M energy conservation opportunities, information on passive solar design, or the results of last year's wind machine testing. Published quarterly, the Newsletter prints just about anything on energy.

Second, "Energy Techdata" sheets analyze, in as short a form as possible, engineering theory, equations, application notes, pros and cons, and economic figures needed to evaluate or design a particular piece of equipment or system. "Energy Techdata" sheets may show a generic analysis or include brand-name comparisons. AFESC's first Techdata sheet about heat pump water heaters is an example. Techdata sheets are mailed to BCEs as they're generated, normally, every month or two.

Third, Technical Reports (TRs) published by the Center's Energy R&D Office provide detailed data and recommendations resulting from in-depth Center energy studies. Most of the research work reported in these documents is relevant to specific technologies in which the Air Force has a peculiar need not found in industry or the DOE. For example, aircraft hangar conservation techniques is the subject of the latest report. Technical reports are written at the conclusion of each R&D effort and are routinely mailed to MAJCOM/DEs and other laboratories. Distribution to the bases is generally left up to the MAJCOMs, although reports analyzing specific bases are usually mailed to those bases. Synopses and ordering information for these reports appear in the "Energy Newsletter" or "Energy Techdata" sheet if they conform with current policy. Reports of especially high interest will usually be announced via special letter to MAJCOM/DEs.

Fourth, synopses are provided for AFESC and non-AFESC technical reports which the Center feels are of interest to energy engineers. The synopsized reports may deal with anything from engineering technology to energy market analyses but will usually be those perceived to support current Air Force policy. Thus, while a synopsized report may contain an Air Force, DOD, DOE or commercial disclaimer, the local engineer should feel confident the content does not conflict with reviewers' perspectives. The Center feels this is important because, with the mind-boggling volume of good and bad energy information, it's nice to know that an idea has at least a chance of surviving professional criticism.

Each of the four documents described undergoes a complete review process at the Center.

"Energy Techdata" sheet development is performed by AFESC's Technology Applications Group (TAG). The TAG is chaired by the Energy Group (AFESC/DEB) which acts as the focal point for all Air Force facility energy activities. The TAG consists of members of the Center's R&D and O&M offices. Additional agencies are also invited, depending on the subject. Once a Techdata sheet has been approved by the TAG, it is further coordinated with other staff engineering and services personnel. The final product can be viewed as creating, or complying with, current Air Force energy policy.

The "Energy Newsletter," on the other hand, is developed by the Group's Facility Energy Assistance Team. Most of the newsletter content comes from what the team observes when it visits bases to perform an energy assistance visit. The team also solicits articles on the latest in renewable energy and new energy conservation techniques. The newsletter is prepared and edited by the team and reviewed within the Energy Group.

Complete technical reports generated by AFESC laboratories do not receive an energy policy review before distribution. In fact, they are usually accompanied by a disclaimer of policy compliance. There are two reasons for this. First, the reports are frequently

written by contractors whom AFESC hired to perform a particular study. Their results must be weighed against contract requirements, not Air Force policy. Second, the researchers' conclusions are — and, scientifically, should be — theirs and not someone else's.

The AFESC Technology Transfer Program draws its information from many sources. In addition to those already listed, the Center recently activated two Research and Technology Liaison Offices (RTLOs), one at Golden, Colorado, and the other at Kirtland AFB, New Mexico. Both offices are collocated with the DOE office at each location. The Golden office has access to the resources of the Solar Energy Research Institute (SERI) and contacts at the Air Force Academy laboratories and many energy-intensive firms in that area. The Kirtland office draws on expertise at Sandia, Los Alamos and Lawrence Livermore laboratories. Often, a call to either RTLO can put the Center in touch with the nation's leading experts in any given energy technology.

The Center will soon be on line with the SERI Solar Energy Information Data Bank. Access permits immediate retrieval of research and construction status/problems, solar data from national recording stations, status of congressional energy legislation, project proposals and advertisements, technology assessments, educational opportunities, calendars of events, and much more. Soon, the Center will also purchase access to Oak Ridge National Laboratory's RECON program, allowing instant review of just about any energy technical report ever published.

The Center also monitors energy activities in the field. Just about every base has some sort of advanced energy system or program, the results of which should be made known to the rest of the Air Force. Much of the Center's internal knowledge comes from assisting in design and monitoring construction and operation of these projects.

Primarily, it is contacts such as these from which the Center decides what information should be published. Unfortunately, too many of the Center's field contacts to date have actually been solicited by the Center. Most Air Force engineers have too little routine contact with the Center or its energy personnel to realize the benefits the Center can offer. Yet, the 10-year Air Force Facilities Energy Plan, the Center's Energy R&D Plan, and many energy policy decisions are made from those contacts. It is therefore in the interest of bases and MAJCOMs to contact the Center, feedback information, and discuss energy problems as they arise. Such calls have increased since creation of the Center's Energy Group, but the word has not reached everyone.

In summary, AFESC's Technology Transfer Program is intended to keep Air Force engineers current in energy technology. Through reasonably few publications and an immense information resource, the Center can do just that. To be effective, the program must deal with subjects of need and interest to the energy policymaker and practicing engineer. Information and program feedback from all of the engineering and services community will make it happen. E&S

The Energy Awareness Brochure

by Capt James F. McEvoy, Station Civil Engineer, King Salmon AFS, Alaska

Energy awareness is the easiest and cheapest energy conservation measure a base can take, and although there are no figures to substantiate the claim, it may be the best. To improve energy awareness, **The Civil Engineering Energy Awareness Brochure** was written and is available to any unit wanting a copy.

The Brochure was written for base energy conservation officers and their bosses. It does not have all the answers nor does it claim to be a definitive guide. It is intended as a basic guide and to arouse the imagination and initiative of the reader into increasing and improving existing energy awareness programs. The programs presented are simply one base's efforts in attempting to win the energy conservation attitude game. All the programs were developed using the premise that energy conservation is an attitude and that favorable attitudes can be developed through effective programs.

It is impossible to run an effective overall energy conservation program without establishing a homogenous blend between projects and programs. Bases that are making their conservation goals on projects alone are not reaping all their potential savings. What good is an insulated door if it is not closed or a storm window that is left open, or a flow-restricting showerhead on a leaking hot water faucet? If we do not win the attitude game with our people, our projects are being short-changed. How to change these attitudes is the theme of the Brochure.

Each program (one program per chapter) is presented as complete as possible. An attempt is made to cover all the details of each program and a great many actual program documents are attachments to each chapter to make the implementation as simple as possible.

The three-day pass program outlined in one of the chapters is unique in that only one other Air Force base was involved in the Mock Utility Billing Program. Obviously, other bases cannot implement such a program, but again, other bases have unique situations that afford them one-of-a-kind programs also. The point is that you make a program work with what you have.

This tool is not intended to stifle the creativity or initiative of any program. Its purpose is to plant a few seeds from which effective energy awareness programs can grow and develop. It is a guide for changing attitudes and priming imaginations, for an energy conservation program is only limited by the energy conservation officer's imagination.

Enough copies for every base were mailed to major command headquarters. If you have not received a copy, contact your respective major command and ask for it.

The Air Force has long been aware of the potential damage from inadequate hazardous waste. Actions are continuing to create an on-going awareness of our common goal: to maintain a clean and safe environment.

Those Deadly Hazardous Wastes

by Richard C. Kibler, PE

Hazardous wastes have been produced in America since the beginning of the industrial era. They are being generated today and will continue to be generated in the future. Hazardous wastes are produced by people in their day-to-day lives as they provide the products and services needed and expected by our contemporary society.

Adequate technology exists to deactivate or dispose of these wastes in a manner compatible with the environment. However, since these wastes are an unwanted by-product of our operations, they do not receive the same attention as those items we strive to produce or the services we so successfully provide. In the past, we have sought the cheapest way to remove these wastes from the work area or to dispose of them with little thought to the environmental consequences. The Environmental Protection Agency (EPA) surveyed waste disposal practices to determine the compatibility of these practices with the environment. It found that less than 10 percent of the hazardous waste being generated was being disposed of in an environmentally safe manner. However, it was not this EPA survey that has aroused the public indignation and created the outcry for more stringent hazardous waste controls; it was the deadly fruit of those very same disposal practices surveyed.

In the early hours of 19 July 1978, a young truck driver backed his truck up to a state licensed waste disposal pit in Louisiana. He opened the valve on the tank of his truck; and seconds later, he was dead. The coroner's report showed he died from inhaling toxic fumes caused by a reaction of mixing liquid wastes in the open pit. The same area is surrounded by a river, a fishing lake and a canal, and had a history of flooding.

While the death of this young man is tragic, the long-term impact of this disposal site may be much

more grave. People subject to chronic exposure of toxic wastes often suffer those fates more dreaded than instant death — cancer or birth defects in their children.

This incident is not one-of-a-kind; others have occurred at Toone, Tennessee; Niagara, New York; Lowell, Massachusetts; Akron, Ohio; Plainfield, Connecticut; and Muskegon, Michigan. The list goes on and on. A point to make is that **more than 344 million metric tons** of hazardous industrial waste are disposed of annually. If only 10 percent of this waste is disposed of in a safe manner, then over 310 million tons are disposed of in an unsafe manner. This is evident in that EPA has documented over 400 cases of damage to health or the environment resulting from improper hazardous waste management.

The Air Force has long been aware of the potential damage from inadequate hazardous waste management. **AFR 161-33** requires that the base bioenvironmental engineer review hazardous waste management practices in the work place, maintain files on materials used and wastes generated, and identify whatever actions are necessary to protect the health and welfare of Air Force personnel. The Directorate of Engineering and Services at the Air Staff and the Air Force Engineering and Services Center (AFESC) have provided policy and technical guidance on all areas of pollution abatement. The Directorate has identified hazardous waste management as a prime concern for the 1980s.

The recent EPA regulations implementing Subtitle C of the Resource Conservation and Recovery Act (RCRA) will levy on the Air Force, as it does on industry, a tremendous workload. It requires that the Air Force report to EPA the wastes it generated by August 1980; apply for EPA permits for storage, transportation and disposal by November 1980; and initiate a manifest system to track hazardous wastes from generation to ultimate disposal. The Air Staff has recognized that this administrative requirement is time consuming and requires redirection of resources already designated for health, safety and environmental protection.

To minimize this effort, the AFESC has gleaned the mandatory requirements from the EPA regulations and provided them to the field in simple, easy-to-read implementing instructions. Environmental people at base level have identified the wastes generated and submitted the required EPA Notification Forms; and they are now applying for the required permits. The Air Force will meet EPA's regulatory deadlines.

However, hazardous waste management as required by RCRA is not a program where you file a report, apply for a permit and then forget it. The program requires continued review of waste handling practices, development of contingency plans for treatment, storage and disposal facilities; training of personnel in handling techniques; and maintaining records of these activities. This additional bookkeeping requirement, while being burdensome, should also improve our operations and insure that the base is in conformance with Air Force policy and applicable Federal regulations.

The following are examples of conditions found at several Air Force installations as the result of AFESC visits. These conditions were corrected by the personnel concerned when they were told the practices were illegal. However, they would not have existed if adequate emphasis had been placed on pollution abatement and personnel had been properly trained.

Base "A" operated a small plating shop. The floor wash down and splash-over from the plating baths were discharged to a sanitary sewer. In the National Pollution Discharge Elimination System Permit (NPDES) application, no reference was made to this discharge even though the NPDES regulations required reporting of cadmium, cyanide and chromium wastes such as those being discharged by the base to the waste treatment facility. EPA issued the base a NPDES permit for the waste treatment facility based on the data furnished by the base and made no allowances for the cyanide or metals; therefore, even though the base had a discharge permit, it was still in violation. However, base personnel did not realize this. They erroneously assumed the permit regulated only those wastes listed and that other wastes were unregulated; so they continued to discharge toxic cyanides, cadmium and hexavalent chromium to the receiving stream.

Base "B" stored pesticides in leaking containers on the approach slab to the pesticide shop. Personnel also washed down application equipment on this slab. The drainage from the area was to a ditch through a wooded area and to a major waterway which was used for sports fishing, swimming and as a drinking water supply. This operation was a direct violation of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and Air Force policy guidance. However, the activity manager stated every six months in the Management by Objectives Report, which is used by the Air Staff to determine Air Force compliance, that their operations were in compliance with FIFRA, DOD and Air Force regulations.

Base "C" had implemented a petroleum products segregation program to facilitate recycling of waste products. Drums were placed at points around the base for the collection of waste oils and solvents. Buckets were placed under outlets on supply drums and a schedule for collection was established. The program planning was excellent; however, the cooperation of shop personnel was lacking. Little care was exercised in pouring waste oil into containers, thus resulting in spillage and non-point source pollution. Buckets to collect drippings were neglected and allowed to fill with rainwater and run over, and probably worst of all, from a program success standpoint, the waste petroleum products, when collected, were all randomly placed in the same area and advertised for disposal by the Defense Property Disposal Service as "Waste Oils and Sludges."

This same Defense Property Disposal office also maintained a yard for the storage of hazardous liquids prior to disposal. Bungs for drums were in short supply on the base so personnel were allowed to remove the bungs from drums of waste oils, solvents and transformer fluids stored in the yard. This resulted in severe contamination of the soil and drainage area adjacent to

the yard.

These undesirable practices are all in violation of existing regulations and Air Force policy. As of 19 November 1980, they will be in violation of RCRA and, of course, will make the Air Force and base commander liable to a $25,000 a day fine for each day the violation exists. The mandated inspection and training requirements will also develop an awareness which will result in detection of these type problems and prevention from future occurrence.

While the implementation of RCRA requirements may not improve the already conscientious efforts at most of our installations in hazardous waste management, it will prevent incidents such as those previously stated and create, in other than environmental areas, an awareness of our common goal — a clean and safe environment. Also, it will improve present haphazard practices in industry and totally eliminate midnight dumpings and conditions such as in Iberville, Louisiana, and Toone, Tennessee. E&S

RICHARD KIBLER *is the Hazardous Waste Program Manager in the Environmental Planning Directorate, Headquarters Air Force Engineering and Services Center, Tyndall AFB, Florida. He has bachelor's degrees in civil and chemical engineering, a master's degree in environmental engineering and an associate's degree in environmental law. He is a registered Professional Engineer in six states.*

Environmental Awards for 1979 presented

Avon Park Air Force Range, Florida was the recipient of two citations in the General Thomas D. White Environmental Competition for 1979. McClellan AFB, California was also named an award winner. General Robert C. Mathis, Air Force Vice Chief of Staff, made presentations to the winners in ceremonies at the Pentagon on 29 August.

Avon Park AFR was selected as the winner of the Installation Natural Resources Conservation Award. Col George Wehling, Commander, 56 Combat Support Group, McDill AFB, accepted the award on behalf of Avon Park AFR. Mr. Paul F. Ebersbach, Natural Resources Manager, Avon Park AFR, received the personal award as the individual who contributed the most to the natural resources conservation program during 1979.

McClellan AFB was presented the Environmental Quality Award. Maj. Gen. Dewey K.K. Lowe, Commander, Sacramento ALC, McClellan AFB, accepted the award for the base.

The annual awards are designed to stimulate interest and recognize outstanding achievement in environmental protection and conservation of natural resources.

Food for Thought

There are 294 dining halls, 68 flight kitchens, 55 alert kitchens, 66 crash/fire kitchens, 21 pastry kitchens, and 166 other food service facilities open for business in the Air Force.

The daily grocery bill is $344,167.

Almost $83,000 worth of meals is paid for by personnel receiving Basic Allowance for Subsistence (BAS).

275,730 meals are prepared/served each day. Human energy consumption (calories) exceeds 896,000. Over 643,000 gross pounds of food is prepared. Cleaning up is big business:

- 280,000 trays;
- 551,000 glasses;
- 1.5 million dishes;
- 827,000 forks, knives and spoons; and
- 50,000 pots and pans.

Rinse water alone exceeds 330,000 gallons.

Hot water boosters use 33,600 kilowatt hours.

$192,000 is spent on contracting.

132 contracts are in effect.

4,285 Air Force Food Service people go to work each day.

550,000 people go in/out of dining facility doors daily.

59 bases operate under A La Carte System (ALACS).

Where does the energy go?

45 percent in food preparation;
32 percent for heating, ventilation, air conditioning;
13 percent to sanitation, cleaning and washing;
8 percent for lighting; and
2 percent for refrigeration.

Our people plan menus: for tomorrow, next week, next year.

Tomorrow we do it again!

26 Selected for Promotion by Lieutenant Colonel Board

Twenty-six engineering and services officers were selected for promotion to lieutenant colonel by the CY 1980 Temporary Lieutenant Colonal Board. For Civil Engineering officers, 20 out of 33 first time eligibles were selected, for a 61 percent showing. For Services officers, three out of five first time eligibles were named, for a 60 percent showing. The Air Force line was 64 percent. Selectees include:

Barbeau, Jack W.
Carr, Virgil J., Jr.
Coullahan, Richard
Courter, Robert J., Jr.
Davis, Larry L.
Desantis, Dom A., Jr.
Fiebig, Robert R., Jr.*
Franklin, Eldon G.
Gorges, Thomaws W.
Jones, Michael F.
Kinton, David W.
Lafoy, Joe C., Jr.
Leftwich, George E. III*
Leonhard, William E., Jr.*
Mabry, Everett L.
McCulley, George G. II
Moeller, George H.
Page, Warren L.*
Pyrz, Anthony P.
Shealy, Phillip T.
Tanaka, Milton K.
Valente, George A., Jr.
Voss, Charles B.

Below the Zone

Sugg, Joseph P.*
Walls, Charles O., III*
Zody, James G.*

*Senior School Selectee

When Little Rock AFB decided to reduce the power demand in family housing units on base, it called for the installation of radio controlled switches to turn off electrical power during peak hours. Here's the report on how the base succeeded in

Flattening the demand for power

by William E. Arnold, PE

When Headquarters Military Airlift Command (MAC) implemented an electrical demand reduction program throughout the command in 1976, the civil engineering organization at Little Rock AFB, Arkansas, took actions which brought about a reduction in the billed peak demand for the base. **Figure 1** depicts the results for the past five years.

At the beginning of this program, civil engineering placed emphasis primarily on the summer months. Engineers prepared a demand reduction plan to be implemented in those instances of extreme ambient temperatures and high air conditioning loads. The plan was designed to be implemented in three stages varying in degree from raising air conditioning thermostats two degrees and reduction in appliance and equipment use in Stage 1 to actual turn off of air conditioning units in selected buildings in Stage 3. Although this plan was helpful, they quickly realized it was not the answer because of the detrimental impact it would have during days of extended temperature extremes.

Construction projects were initiated to improve the base's power factor (PF), and the Air Force, at the base's recommendation, intervened in a rate hearing and obtained a new clause in the rate to give a financial credit for PF correction over .90. Projects were also completed to install insulation in walls and ceilings of most base industrial buildings, as well as storm windows, and to install high intensity sodium lights in all large hangars and maintenance buildings. This work resulted in reducing the base air conditioning load by 1015 KWs and the lighting load by 400 KWs during the peak demand period of the day. The greatest impact was noticed in the summer peak demand reduction for FY 1976 and FY 1977 as shown in **Figure 1.**

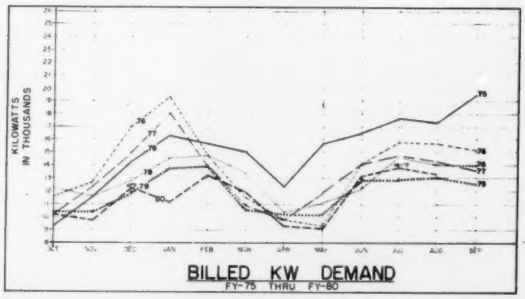
In FY 1978 and FY 1979, over $1.7 million in energy conservation projects were completed in the family housing area on base. Since the housing area is 100 percent electric, these projects have had a dramatic effect upon the demand during the winter as well as the summer months. As seen in **Figure 1,** the peaks for summer and winter for FY 1979 flattened dramatically when compared to previous fiscal years.

Even though the electrical load in the base industrial area had grown at least nine to 10 percent during the five year period, and a new 80,000 square foot hospital addition was brought on line during the spring and summer of FY 1979, the monthly electric bill was cut considerably as the demand charges were reduced. The FY 1979 total demand was 39,097 KWs less than KY 1975 and, at $2.75 per KW of demand, this equated to a savings of $107,500 for FY 1979 alone. Because of an electric rate increase in June 1980, the demand charge was increased to nearly $6.00 per KW during the summer months. The FY 1980 demand charges at this new rate will equate to nearly $150,000 saved when compared to FY 1975.

During the latter months of FY 1979 the family housing demand deferment project which involved the installation of 1,547 radio control switches was completed. This system was originally planned to switch air conditioning units (ACU) off for 25 percent of the time during peak demand hours of the day during the summer months. With 1,547 switches installed and an approximate 4 KW load per ACU, the load shed would have been 1,547 's off the monthly peak demand.

Through actual experience conditions, it was found that the units could be switched off 33 percent of the

Figure 1: Billed Kilowatt Demand.



time with no discomfort to the occupants. This equated to a reduction in peak demand of 1900 KWs per month. During a two-week period this summer, temperatures at Little Rock AFB ranged from 100 degrees F to 108 degrees F. Action was taken to switch 50 percent of the ACU off during the late morning hours and remain in this mode until between 1700 and 1800 daily (see **Figure 2**). One can see from the figure that on 2 July 1980, the temperature reached 107 degrees F. The normal curve line represents a design condition day, and load shedding of 33 percent for the radio switches. By switching off the units 50 percent of the time during the peak demand time, the base reduced its demand nearly 3,000 KWs (1,547 switches x 4 KW x .50); this represents an $18,000 savings during the month of July 1980. Coupled with this saving, engineers noted little dissatisfaction by family housing occupants and that temperatures had not gone up excessively in the houses because of the energy conservation projects already accomplished in the housing area; and the local utility company was able to defer constructing this much additional plant capacity because of demand deferment. (It should be noted that Arkansas Power and Light Company has 38,000 radio switches on its system at this time.)

In addition to the energy conservation and demand deferment measures, the base is approximately 80 percent complete on a project to replace its existing 1,547 heat pumps with new high efficiency units. Although this was primarily a repair project, the base is benefiting in reduced equipment capacity which appears to be an approximately 15 percent reduction in energy use as well as a reduction in demand. Some impact was felt on the demand as depicted in **Figure 1** for the summer of FY 1979 and the winter of FY 1980. The base is currently experiencing a reduction in demand for FY 1980 and engineers anticipate, as this project is completed, to further reduce the demand in the months to come. In spite of the massive heat wave of 100 degrees F plus days in July and August 1980, the peak through August was 13,800 KWs. Additionally, the project for the Energy Monitoring and Control System is nearing completion and when it is on line, engineers anticipate that even more control of peak demand will be possible in the future. E&S

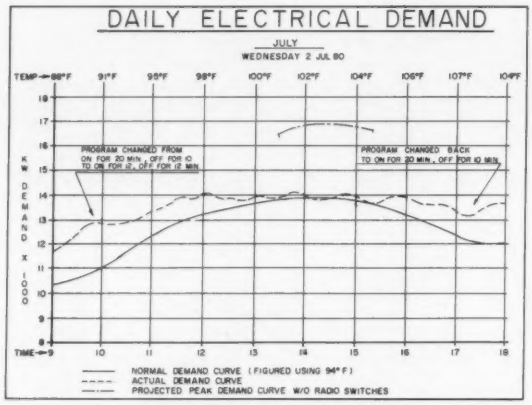


Figure 2. Daily Electrical Demand.

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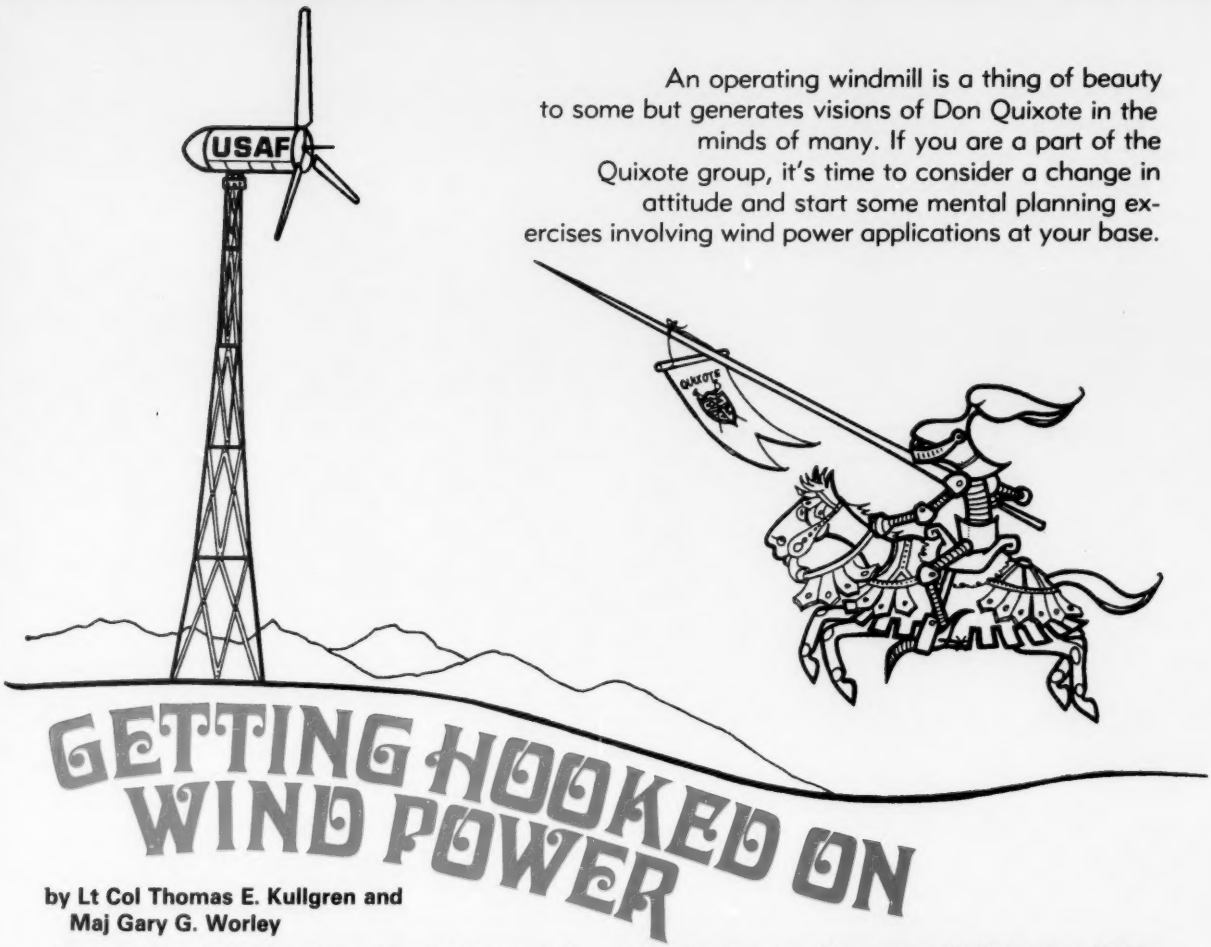
Trash to Energy Via RDF

Continued from page 16

With the first leg of the research program completed and Phase II well underway, Wright-Patterson AFB is actively "beating the drum" to encourage local development of a resource recovery facility. The reason is fairly clear. While the scientific studies during the next few months will provide a critical evaluation of the program, we are confident that burning RDF is feasible and can be economical.

Beginning in October 1981, the base will have the capability of burning 50,000 tons of RDF per year. A local supplier of the pelletized fuel using state-of-the-art recovery systems can easily compete with the price of coal on an equivalent energy basis. Although less predictable than other energy markets, coal is expected to follow a similar cost spiral as oil and natural gas. As better equipment and techniques for resource recovery come on line, RDF unit costs are predicted to stabilize and possibly fall. The net affect of burning 50,000 tons of RDF is a replacement of 25,000 tons of coal, and a possible savings in O&M fuel costs of from $500,000 to $1 million annually. Further enhancing the economics of this scenario are cost avoidances for reduced refuse transportation and disposal expenses if the resource recovery facility is located near the base. Currently, trash is transported to a landfill 10 miles away that may soon require substantial capital improvements to stay in business.

In a nutshell, the RDF program at Wright-Patterson AFB promises to provide a renewable source of economical, clean burning fuel and environmentally dispose of both base and local community solid waste for years to come. From all appearances, the concept is a "marriage made in heaven." E&S



An operating windmill is a thing of beauty to some but generates visions of Don Quixote in the minds of many. If you are a part of the Quixote group, it's time to consider a change in attitude and start some mental planning exercises involving wind power applications at your base.

GETTING HOOKED ON WIND POWER

by Lt Col Thomas E. Kullgren and Maj Gary G. Worley

An operating windmill is a thing of beauty to some but generates visions of Don Quixote in the minds of many. If you are part of the Quixote group, it's time you consider a change in attitude and, at the very least, start some mental planning exercises involving wind power applications at your Air Force location. Wind energy is thought by many to be the solar technology closest to commercialization and, thus, has the potential for making a significant contribution toward the President's goal of 20 percent of the nation's energy being supplied by solar technologies by the year 2000. Of the 20 percent, 10-15 percent could be realized with wind machines alone. To achieve this goal, about 25,000 large windmills and 1.6 billion small machines with capital investment of $35 billion from public and private sectors would be required. Ambitious certainly, and perhaps even a bit far-fetched, yet there are some strong indications that this is not a pipe-dream.

Federal Wind Program funding levels are one reflection of public support for predictions that power in the wind could provide a partial solution to the energy crisis. From a very small beginning in 1973, funding for the Wind Program has grown annually to become a major Federal budget item, namely, $87 million for FY 1981. A vigorous demonstration program has led to operational applications in a growing number of US locations. Wind machines, both privately and publicly funded, are up and operating and producing power at costs predicted to soon be quite competitive. For example, the Mod OA 200 kw horizontal axis machine at Clayton, New Mexico has already produced over one-half million kilowatt hours and currently provides 10 percent of Clayton's electrical energy requirements. As a major consumer and tenant on millions of acres of Federal lands, the Air Force would be well-advised to pursue a coordinated program of resource, environmental and market assessment to be prepared for the installation of similar wind machines on Air Force bases.

Timely action is particularly important in the area of resource assessment. Efforts to reduce wind measurement time to less than a year have largely been unsuccessful, in fact, measurement programs of five years or more are often preferable. Therefore, in most locations the earlier recording stations are installed, the sooner information can be available for use by decision makers. The Pacific Gas and Electric Company, for example, initiated a $1 million dollar assessment program in 1978 which will lead to large-scale wind power generation by 1990. "The next five years," say officials of the Electric Power Research Institute, "are crucial in

Capt Steve Boyce of the Academy flies the TALA kite anemometer. Using this system, he samples wind velocity and direction at multiple heights over complex terrain.

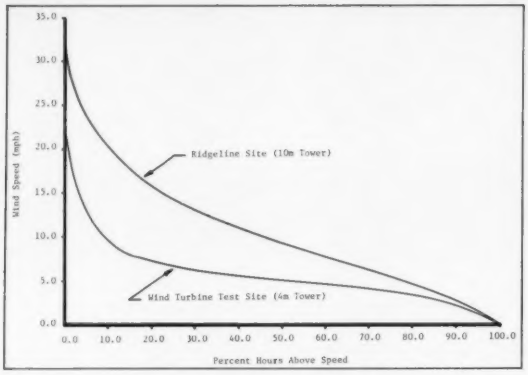


Figure 1: Wind Velocity Duration, Summer 1979.

determining the role wind energy can play ... (and) above all, during the period it is essential that efficient procedures for siting wind turbines be developed ... " ("Going with the Wind," Electric Power Research Institute Journal, March 1980.)

Faculty and students of the USAF Academy Departments of Engineering Mechanics and Civil Engineering have been conducting wind energy research for the Air Force Engineering and Services Laboratory for several years. Upon completion of the design, fabrication and testing of a small vertical axis wind turbine (VAWT), emphasis switched in FY 1980 to a detailed wind survey of the 18,000 acre Academy reservation. Siting procedures developed in this experiment will be used, along with the latest Department of Energy (DOE) wind assessment procedures, to suggest survey and instrumentation techniques at other Air Force installations.

The Academy wind site survey involves four instrumented sites and one mobile recording device. At the VAWT test site, a strip chart recorder produces a continous wind velocity and direction record from a four meter anemometer tower. The remaining three fixed sites have microprocessor based remote recorders with 10 meter towers. One of these sites is a baseline station recording wind velocity and direction at one second intervals. The other two sites record wind velocity only. All three remote fixed sites are on long east-west ridgeline crests. Each device is read biweekly at which time the instrumentation receives a new battery set if required. Raw data is subsequently stored on tape cassettes and analyzed using desktop computers. The mobile sensor is the TALA (Tethered Aerodynamically Lifting Anemometer) system, more commonly recognized as a calibrated kite. The TALA device is enjoying increasing respect as a rather accurate and inexpensive way of instantaneously measuring wind velocity, direction and turbulence to altitudes not possible with fixed stations.

The necessity for such an extensive data collection scheme may not immediately be clear, since the Air Force Environmental Technical Application Center (ETAC) has been compiling and analyzing wind information from Air Force bases for years. Without question, this climatalogical data base will be a key starting point for any methodology intended to rank bases in order of wind power potential. At the same time, the limitations of this information should be understood. The base weather observer records an average wind velocity once each hour over a short time interval just prior to the hourly report. The observer's anemometer is commonly located near the approach end of a runway on a short tower 13 feet above the runway centerline. The velocity information then becomes an "occurrence" and is so recorded. Such a data base has the following limitations for wind power calculations:

• The short averaging time once hourly does not adequately reflect the wind speeds during the re-

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mainder of the hour.

- **Observers have a psychological bias to recording "even-numbered" rather than "odd-numbered" wind speeds and are more prone to record wind speeds in increments of five knots.**
- **Wind information from low towers is difficult to extrapolate to higher altitudes more indicative of windmill hub height. The extrapolation parameters are a function of velocity and terrain roughness so standard values cannot be used with any assurance at all locations.**
- **Anemometer location is established to assist aircraft operations and not energy applications. Extrapolation to potential wind machine sites in the horizontal plane has yet to be proven successful in wind energy applications.**

In spite of these limitations, there are strong statistical indications that the ETAC data base at sites with long records is quite useable for that specific anemometer location and height. This is not to say that one cannot find a better site (with some effort) or, for that matter, a much worse site (with much less effort!) on an Air Force base.

The time invested in "prospecting" for wind can be time well spent. Since power available in the wind is a function of the wind velocity cubed, an increase in the average wind velocity from 10 mph to 13 mph would yield a 100 percent increase in the power available. **Figure 1** shows a comparison of two Academy sites in the form of wind speed versus percent time above speed. The ridgeline site could be called fair to good while the turbine test site (chosen only for convenience in testing) would be classified as a poor site. Simple calculations for these two sites show an average power density of 150.4 watts per square meter on the ridge and only 21.1 at the turbine test site. But that is not the final assessment. **Figure 2** shows a typical record from flying the TALA kite over the same ridgeline site. This figure shows a dramatic result. Velocities approaching (in this case exceeding) the reference velocity measured at 220 meters above the ridge could be realized by a wind machine on a 20-40 meter tower at that site! Of course, this result is site specific and only applies to winds blowing approximately perpendicular to the ridgeline (the prevailing direction). Attempts are ongoing to integrate this information to that recorded at the 10 meter anemometer height on the same location.

Surveying a base for high energy density sites is, at this writing, not a strict science but rather an art as evidenced by the phrase "prospecting for wind." The Academy project is a learning experience but will lead to recommendations for surveying other bases in an organized fashion. A few impressions from our experience can, however, be shared at this point. First, a self-contained microprocessor-based remote recording system is absolutely necessary. Strip chart recorders and wind run devices produce unmanageable output in the first case and limited output in the latter. Secondly, wind site surveying is many times a difficult and somewhat sophisticated task requiring careful data acquisition and reduction. There are, however, some preliminary activities you can perform at your base with little cost of time and money.

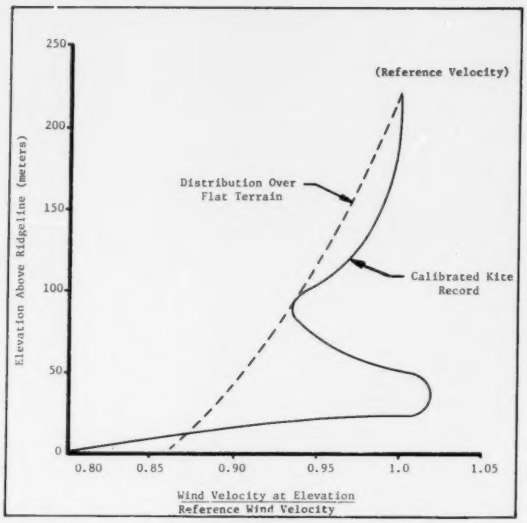

Figure 2: Typical TALA Kite Result Above An Academy Ridgeline.

- Review the wind climatology available at your base weather station in the Revised Uniform Summary of Surface Weather Observations (RUSSWO).
- Obtain additional wind information from and determine the wind energy involvement of your local power company and other non-Air Force agencies. Include sources as diverse and seemingly unreliable as local mythology about "known windy places."
- Look over your plant and tree growth. Many of types of vegetation respond to long-term wind patterns.
- Get on DOE mailing lists for free wind information. Consider joining the American Wind Energy Association, a national organization representing the wind energy community.
- Last, but not least, prepare to get "hooked" on wind power as a benign, naturally renewable, seemingly inexhaustible alternate energy source just waiting to be captured!

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E&S

Built in the early 1930s, the Randolph Base Chapel represents a commitment to architectural detail which is prevalent throught the base. The United States Army Quartermaster Corps designed the building and boldly incorporated motifs from two of San Antonio's famous missions. The rose window is from Mission San Jose and the twin towers are from Mission Concepcion. The rendering is an artist's impression based partly on reconstruction from the original architectural working drawings of the Quartermaster Corps.

*U.S. GOVERNMENT PRINTING OFFICE: 1980-640-338/4